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Parents as Agents of Change for the Prevention of Obesity in Young Children

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Parents as Agents of Change for the Prevention of Obesity in Young Children

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The purpose of this research was to determine the effects of a weight loss program on maternal nutrition knowledge and the diet and activity of her 1-3 year old child. In addition, physical, demographic, dietary, and psychosocial factors related to child weight-for-height were examined. All four studies utilized data from one sample of low-income, tri-ethnic mothers and children (n=191). In study 1, a food frequency questionnaire (FFQ) for 1-3 year olds was developed and validated in 77 tri-ethnic, low-income mothers who completed FFQs and 3-day diet records for their child. Reliability was evaluated by comparing food group servings/day on test- and retest-FFQs. Concurrent validity of the FFQ as compared to 3-day diet records also was determined. Mean coefficients were 0.69 for reliability, 0.41 for validity, and 78% of the children were

classified correctly. In study 2, 91 Hispanic, African American, and Caucasian, overweight/obese mothers of a 1-3 year old child participated in an 8-week program emphasizing healthful eating, exercise, and lifestyle changes. Energy intakes of the child were reduced to acceptable levels, and both mothers and children decreased total/saturated fat, high-fat snacks/desserts, sweetened beverages, and fast foods, and increased home-prepared meals. Physical activity also improved in both mothers and children. In study 3, 101 tri-ethnic, low-income 1-3 year old children and their mothers were measured for height and weight and mothers completed demographics, psychosocial, and child dietary data. Multiple regression revealed that the modifiable factors of mother's weight and child's inactivity and lower % of energy from carbohydrate, and the non-modifiable factors of family history of diabetes and child's age were related to greater child weight-for-height. These factors explained 29% of the variance in weight-for-height. In study 4, the relationship of nutrition knowledge to weight loss in 141 low-income, tri-ethnic mothers of children 8-months to 12-years was examined. The intervention improved the nutrition knowledge of mothers in all areas of interest. Participants who achieved successful weight loss ($\geq$ 5 pounds) had greater nutrition knowledge on both pre- and at post-tests than those who did not lose weight. Responders appeared more cognizant of information about diet, health, and weight loss.

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Chapter 1: Review of Literature

The epidemic of obesity has become one of the most significant public health problems in the United States. In adults 20-39 years of age 57% are overweight and 25% obese (Hedley et al. 2004). The prevalence is even higher in ethnic groups as 61% of Hispanic women and 70% of African American women are overweight. Of these, 31% and 46% are obese, as compared to 49% overweight and 24% obese in Caucasians (Hedley et al. 2004). In addition, women of lower socioeconomic status are 50% more likely to be obese than those from higher income/education backgrounds (U.S. Department of Health and Human Services 2001).

Obesity is also on the rise in very young children. Data from the NHANES 1999-2000 revealed that 11% of infants from birth to 23 months are classified as overweight ($\geq 95^{th\%ile}$ of weight-for-length), as compared to only 9% in the previous survey from 1988-1994. In 2-5 year olds, 10% are overweight ($\geq 95^{th\%ile}$ of body mass index-for-age), an increase from 7% in NHANES III. An additional 12% of 2-5 year olds are overweight or at risk ($\geq 85^{th\%ile}$ of body mass index-for-age) (Ogden et al. 2002; Hedley et al. 2004). Minority children are also disproportionately affected (Ogden et al. 2002; Hedley et al. 2004).

In children, obesity can lead to orthopedic abnormalities, asthma, insulin resistance, sleep apnea, hypertension, type 2 diabetes (American Obesity Association 2002). For example, almost 60% of overweight 5-10 year old children already have one cardiovascular risk factor and 20% have two or more (Freedman et al. 1999). In the past, type 2 diabetes was regarded as an adult onset disease, but recently it has been seen in obese children as young as 10 years old (Fagot-Campagna et al. 2000). Other detrimental effects of overweight in children are negative body image and poor self-esteem (Freidlander et al. 2003, Morgan et al. 2002).

Prevention of obesity in young children may be the most cost-effective strategy to fight the obesity epidemic. Early intervention to promote healthful food choices is important because once poor dietary habits are engrained; they may be difficult to change. Obesity also runs in families and the strongest link is between mother-child pairs (Melgar-Quinonez and Kaiser 2004, Whitaker et al. 2004). For these reasons, weight management programs in overweight/obese mothers that emphasize diet and physical activity modifications for the entire family are critical in young children before overweight develops.

DEVELOPMENT AND VALIDATION OF FOOD FREQUENCY QUESTIONNAIRES

Collection of Dietary Intake in Children

Obtaining accurate information regarding the food intake of young children is difficult as their food habits are changing constantly, portion sizes are difficult to quantify, and many children eat meals away from their parents. One way to compensate for these potential problems is to obtain multiple measures of dietary intake [i.e. 24-hour recalls, food records, and food frequency questionnaires (FFQs) (Frank et al. 1986)]. Since food records and recalls capture only a brief period of time, FFQs are useful for obtaining more generalized patterns.

Parents of young children must be relied upon to provide the dietary information for their child. Self-report measures can be used with older children and adolescents, but not in preschool children, as they are not developmentally advanced enough to recall foods eaten and portion sizes (Krall et al. 1988, Samet et al. 1998). Typically, FFQs designed for young children are modified versions of the adult FFQs that incorporate foods commonly eaten by children and smaller portion sizes (Stein et al. 1992). FFQs also should include age- and culturally-appropriate foods, changes in food supply, fat-modified foods (Kennedy and Bowman 2001), functional foods (Milner 2000, Roberfroid 2000), and foods prepared away from home.

Design of Food Frequency Questionnaires for Young Children

Although FFQs have been designed for young children, a review of the literature revealed that many cannot be used in a tri-ethnic sample of 1-3 year olds from low-income families (Table 1.1). Only three validated questionnaires have assessed food choices in 1-year olds. These include those for low-income Native Americans and Anglos (Blum et al. 1999) and middle- to upper-income Whites (Marshall et al. 2003, Parrish et al. 2003). Four others could be used with 2-3 year olds, including those for Swedish (Blom et al. 1989), Hispanic (Stein et al. 1992), New Zealand (Taylor and Goulding 1998), and Anglo and African American populations (Treiber et al. 1990). Of these, only two have been validated in children from low-income families (Blum et al. 1999, Stein et al. 1992). To our knowledge, age-appropriate and culturally-sensitive FFQs have not been validated for a low-income, tri-ethnic population of 1-3 year olds.

Additional FFQs validated in other age groups are those by Kaskoun et al. (1994): 4-6 year olds; Persson and Carlgren (1984): 4- and 8-year olds; Hammond et al. (1993): 5-11 year olds; Byers et al. (1993): 6-10 year olds; Arnold et al. (1995): girls 7-12 years; Baranowski et al. (1997): 3rd grade children only; Bellu et al. (1996): 8-10 year olds; Perks et al. (2000): 8-16 year olds; Bellu et al. (1995): 9-12 year olds; Domel et al. (1994): 4th-5th graders; Field et al. (1999): 4th-7th graders; Jenner et al. (1989): 11-12 year olds; and Rockett et al. (1995 and 1997): 9-18 year olds.

Table 1.1. Food frequency questionnaires for use with young children

Reference	Child age/grade	Ethnicity and/or socioeconomic status	Instrument	Major limitation
Marshall et al. (2003)	6 months-5 years	240 children: primarily Caucasian and middle- to upper-income	7 items; only includes beverages; parents completed questionnaire	Only assesses beverage intake
Parrish et al. (2003)	1-3 years	68 children: at risk for type 2 diabetes; primarily Caucasian and middle- to upper-income	111 item Willett[a] FFQ; parents completed questionnaire	May lack culturally and age-appropriate foods
Blum et al. (1999)	1-5 years	233 children: 102 Anglo and 131 Native American; low socioeconomic status	84 items; adapted from Willett[a]; past month; parents completed questionnaire	Expensive to use/analyze; may lack culturally appropriate foods
Blom et al. (1989)	2-16 years	30 children in Sweden: 15 with type 1 diabetes; 15 healthy	36 items (foods of interest in type 1 diabetes); period of recall not specified; parents assisted child	May lack culturally appropriate foods
Stein et al. (1992)	3-4 years	224 children: 91% Hispanic; low socioeconomic status	Number of items not reported; adapted from Willett[a]; past 6 months; parents completed questionnaire	Expensive to use/analyze
Treiber et al. (1990)	3-4 years	55 children: 40 Anglo and 15 African American; primarily middle socioeconomic status	111 items; past 3 months; parents completed questionnaire	Not designed for low socioeconomic status; may lack culturally appropriate foods
Taylor & Goulding (1998)	3-6 years	67 children in New Zealand	35 items (calcium); past year; parents completed questionnaire	Assesses only calcium intake; may lack culturally appropriate foods
Kaskoun et al. (1994)	4-6 years	45 children: 36 Anglo and 9 Native American	<111 items; adapted from Willett[a]; past year; parents completed the questionnaire	Not designed for low socio-economic status
Persson & Carlgren (1984)	4 and 8 years	477 children in Sweden	27 items; period of recall not specified; parents completed questionnaire for 4-year olds and assisted 8-year olds	Uses adult portion sizes; may lack culturally appropriate foods
Hammond et al. (1993)	5-11 years	272 children in Great Britain	35 items (energy, fat, fiber); past month; parents completed the questionnaire	Assesses only energy, fat, and fiber intake
Byers et al. (1993)	6-10 years	97 children: Anglo and African American	35 items (fruits and vegetables); past 3 months; parents completed questionnaire	Assesses only fruit and vegetable intake
Bellu et al. (1996)	8-10 years	323 children in Italy	116 items; past 6 months; parents completed questionnaire	May lack culturally appropriate foods

Perks et al. (2000)	8-16 years	50 children: demographic profile not provided	Willett's Youth Adolescent Questionnaire; past year; child completed questionnaire	Not appropriate for very young children
Bellu et al. (1995)	9-12 years	88 children in Italy	116 items; past 6 months; parents completed questionnaire	May lack culturally appropriate foods
Baranowski et al. (1997)	3rd grade	1,674 children	7 items (fruits and vegetables); adapted from Block[b]; past month; children completed questionnaire	Assesses only fruit and vegetable intake
Field et al. (1999)	4th to 7th grade	109 children: low-socioeconomic status; inner-city; primarily African American	97 items; adapted from Willett[a]; past year; child completed questionnaire (questions read allowed to younger children)	Not appropriate for very young children
Bellu et al. (1995)	9-12 years	88 children in Northern Italy	116 items; past 6 months; parents completed questionnaire	May lack culturally appropriate foods
Rockett et al. (1997)	9-18 years	261 youths: 96% Anglo	131 items; adapted from Willett[a]; past year; child completed questionnaire	Not designed for low socio-economic status
Domel et al. (1994)	4th/5th grade	179 children: Anglo and African American; lower-middle socioeconomic status	45 items (fruits and vegetables); past year; child completed questionnaire	Assesses only fruit and vegetable intake
Domel et al. (1994)	4th/5th grade	179 children: Anglo and African American; lower-middle socioeconomic status	45 items (fruits and vegetables); past week; child completed questionnaire	Assesses only fruit and vegetable
Jenner et al. (1989)	11-12 years	225 children in Australia: children were from different socioeconomic status classifications	175 items; past week; group administered; child completed questionnaire	May lacks culturally appropriate foods

[a] Willett et al. (1985)
[b] Block et al. (1986)

Another consideration is the appropriateness of the instrument for different ethnicities and socioeconomic populations. Researchers have developed FFQs for use in the following populations: Italian (Bellu et al. 1995 and 1996), Swedish (Blom et al. 1989, Persson and Carlgren 1984), British (Hammond et al. 1993), Australian (Jenner et al. 1989), Native American (Kaskoun et al. 1994), Anglo (Rockett et al. 1997), and children of unspecified ethnicity (Baranowski et al. 1997, Taylor and Goulding 1998). In addition, FFQs have been designed for middle- to upper-incomes including those by Treiber et al. (1990), Kaskoun et al. (1994), and Rockett et al. (1997). However, none of these were designed for the ethnic or socioeconomic groups in our study.

Other FFQs for young children have been created to measure limited aspects of the child's nutrient intake. For example, questionnaires have been designed to capture intake of beverages (Marshall et al. 2003), calcium (Taylor and Goulding 1998), fruit and vegetables (Baranowski et al. 1997, Byers et al. 1993, Domel et al. 1994), or energy, fat, and fiber (Hammond et al. 1993). These FFQs are valid for their intended purpose, but are too limited in scope for the present research.

Procedures for Validation of Food Frequency Questionnaires

The majority of psychometric evaluations of food frequency questionnaires in adults and children have been conducted comparing *nutrients* from the questionnaire to a "gold standard" (i.e. diet records, 24 hour recalls, or nutrient biomarkers). Validation also has been accomplished with *foods or food groups* (Willett 1998), as was performed in this study. For example, Marshall et al. (2003) assessed the correspondence of questionnaire foods/food groups to diet record foods/food groups for validation. Although fewer FFQs in children have been validated using foods/food groups (versus nutrients), several in adults have used this technique (Erkkola et al. 2001, Flagg et al. 2000, Sauvaget et al. 2002, van Assema et al. 2002). Others used nutrients or a combination of food-and nutrient-based validation (Blom et al. 1989, Blum et al. 1999, Marshall et al. 2003, Parrish et al. 2003, Stein et al. 1992, Taylor and Goulding 1998, Treiber et al. 1990). One limitation of nutrient-based validation is that nutrients from the questionnaire and diet record may correlate, but the actual foods selected on the two forms may differ (Baranowski et al. 1991). Validation with foods/food groups is particularly useful for examining the performance of specific foods on the questionnaire (i.e. how comparable are the foods and portion sizes recorded on the questionnaire to the diet records) (Willett 1998).

PREVENTION OF OBESITY IN CHILDREN

Timing of Obesity Intervention

Critical periods for the development of overweight in children are during fetal growth, early infancy, the period of adiposity rebound, and adolescence (Dietz 1997). In a cross-sectional study of 5514 children by Stettler et al. (2002), weight gain during infancy was associated with a greater risk for overweight and obesity in later childhood (4 – 17 years) irregardless of birth weight. Adiposity rebound is the age at which BMI increases dramatically after its lowest point in early childhood, occurring between the ages of 4-7 years (Rolland-Cachera et al 1987). In a longitudinal study from age 2-8 years, Skinner et al. (2004) found that early onset of adiposity rebound, greater child BMI at 2 years, and intake of fat and protein were predictive of larger child BMI at 8 years. The factors which cause early adiposity rebound are debatable, but parental obesity (Dorosty et al. 2000) and excess dietary protein (Rolland-Cachera et al. 1987) have been implicated. Thus, interventions before these critical periods of weight gain are important.

Early intervention is also imperative because food habits are formed during childhood (Birch et al. 1998) and obesity becomes more difficult to treat with age (Dietz 1999). A study by Myers and Vargas (2000) reported that 33% and 50% of obese preschool and school-age children retain their excess body fat as adults. Interventions to reduce this epidemic should be designed for families of young children, before overweight develops (Dietz 1999).

Family Problem of Obesity

Parents and the home environment are the strongest influences on the diet and activity behaviors of young children (Stang et al. 2004). Therefore, programs should train parents to be role models for beneficial changes in their child. We focused on mothers with BMI $\geq$ 25 kg/m^2 because maternal weight is a highly significant predictor of child weight (Gyovai et al. 2003, Hediger et al. 2001; Stettler et al. 2002, Williams et al. 1999). By the age of 4 years, 24% of children with obese mothers were already obese themselves (Whitaker et al. 2004). Non-overweight children under the age of 10 who have an obese parent are more than twice as likely to have BMIs $\geq$ 30 kg/m^2 as adults (Williams et al. 1999). In addition, a study by Unger et al. (1990) found that among the obese children surveyed, 63%, 31%, and 50% had obese mothers, fathers, and siblings, respectively.

Family-Based Approach for Treatment

Numerous studies have reported that parental involvement in changing lifestyle, diet, and physical activity habits is critical in the treatment and prevention of child obesity. Using parents as agents of change is superior to traditional approaches targeting only children in weight reduction (Brownell et al. 1983, Epstein et al. 1990b, Epstein et al. 1990c, Golan et al. 1998, Robinson 1999, St Jeor et al. 2002). Table 1.2 summarizes

Table 1.2. Overview of child obesity interventions involving parents as agents of change

Study	Purpose	Description of children	Group		Intervention	Outcomes
			Experimental	**Control**		
Pisacano et al. (1978)	Child obesity prevention	80 non-overweight infants 3-4 months	Group 1 (N=40): Prudent diet No parent education	Group 2 (N=40): Normal diet	3 years	3 years: prevalence of overweight significantly less in group 1
Epstein et al. (1981) Epstein et al. (1987): 5 yr follow-up Epstein et al. (1990): 10 yr follow-up	Child obesity treatment + parent weight reduction	76 obese children 6-12 years	Group 1 (N=30): Parent and child weight loss Group 2 (N=26): Child weight loss Group 3 (N=30): Non-specific target for weight loss	None	8 months (8/wk + 1/month for 6 mos) 21 month follow-up	21 mo.: More children in group 1 were non-obese than 2/3; 100% of newly non-obese group 1 children were non-obese, compared to 30% and 33% in groups 2/ 3, respectively. 5 yrs: Group 1 children lost more weight than 2/3; obese children of non-obese parents maintained their weight loss better than those with obese parents 10 yrs: Group 1 children lost more weight than group 2/3
Brownell et al. (1983)	Child obesity treatment	42 obese adolescents	Group 1 (N=14): Mother-child attended	None	16 weeks (1/wk), 1-yr follow-up	16 wks: Group 1 lost more weight

		12-16 years	separately Group 2 (N=15): Mother-child met together Group 3 (N=13): Child alone			Follow-up: Group 1 maintained wt loss while 2/3 gained
Epstein et al. (1984)	Child obesity treatment + parent weight reduction	53 obese children 8-12 years	Group 1 (N=18): Parent and child weight loss with diet Group 2 (N=18): Parent and child weight loss with diet + exercise	Group 3 (N=17): No treatment	7 months (8/wk + 3 biweekly + 4 monthly), 1 year follow-up	6 month: Parents and children in groups 1/2 lost equal and more weight, respectively than 3 1 yr: Parents in group 2 showed more weight loss than 1; no differences in weight between children in groups 1 and 2
Kirschenbaum et al. (1984)	Child obesity treatment + parent weight reduction	40 overweight children 9-13 years	Group 1 (N=16): Parent-child together Group 2 (N=15): Child alone	Group 3 (N=9): Wait list control	9 weeks (1/wk) 3-mo and 6 mo follow-ups	Wk 9: Parents and children in groups 1/2 lost more weight than 3; no difference in weight loss between groups 1/2 3 mo and 6 mo: Children in groups 1/2 retained weight loss, while controls gained; parents in group 1 sustained greater weight loss than groups 2/3;

						strongest positive correlation between parent and child weight loss seen with group 1
Israel et al. (1985)	Child obesity treatment	33 overweight children 8-12 years	Group 1 (N=12): Weight reduction only (parent-child separately) Group 2 (N=12): Weight reduction (parent-child separately) + parent training (parent alone)	Waiting list control (N=9)	8 weeks (1/wk), 1 year follow-up	8 wks: Parents and children in groups 1/2 lost comparable weight; controls gained 1 yr: Parents in group 2 maintained greater weight loss; group 2 children had slower rate of weight gain
Epstein et al. (1986)	Child obesity treatment + parent weight loss	41 obese children 8-12 years	Obese parents and children on weight loss diet; non-obese parents on weight maintenance diet Group 1 (N=not specified): Parent alone Group 2 (N=not specified): Child alone	None	1 year (eight 1/wk + 10 monthly sessions)	1 and 3 yrs: No differences 1 yr: Obese children of non-obese parents had greater weight loss 3 yrs: No differences among children of obese vs. non-obese parents
Graves et al. (1988)	Child obesity treatment	40 obese children 6-12 years	Instruction for parent-child together	None	8 weeks (1/wk), 1, 2, 3, and 6-month follow-ups	8 wks: Children in group 2 decreased weight

			Group 1 (N=not specified): Behavioral weight reduction Group 2 (N=not specified) : Behavior weight reduction + problem-solving exercises Group 3 (N=not specified): Instruction on diet and exercise only			more; groups 1/2 lost more weight than 3. 6-months: Group 2 children maintained weight loss; groups 1/ 3 gained.
Israel et al. (1990)	Child obesity treatment + parent weight reduction	40 obese children 9-13 years	Instruction for parent-child together: At 4 weeks, parent-child pairs divided into 2 groups: Group 1 (N=12): Weight loss group (parent & child wanting to lose wt) Group 2 (N=28): Helper group (parents-no attempt to lose weight)	None	26 weeks (eight 1/wk + 6 sessions every 3 wks), 1 year follow-up	Wk 8: Group 1 children lost more weight Wk 26: Weight loss only in group 2 children and in group 1 mothers 1 yr: Group 1 children regained greater % weight
Wadden et al. (1990)	Child obesity treatment	36 obese children (African American females only) 12-16 years	Group 1 (N=19): Child alone Group 2 (N=14): Mother + child together Group 3 (N=14): Mother + child separate	None	10 months (16/wk + 6 monthly)	Greatest weight loss in children whose mothers attended more sessions, regardless of if they were in group 2 or 3.
Nuutinen (1991); Nuutinen & Knip (1992b): 2 yr follow-	Child obesity treatment	32 obese children 6-16 years	Group I: Intensive treatment 1A (N=16): Individual	Group 3 (N=29): Normal weight children	1 year: Group 1A: 5 sessions/yr Group 1B: 7	1 and 2 yrs: Group 1 reduced fat intake and body weight more

up			sessions (parent-child together) 1B (N=16): Group sessions + behavior modification (parent-child separately and together) Group 2 (N=16): Conventional school health-care treatment (child alone)		sessions/yr Group 2: 1/month Year 2: All had 2 visits	than 2. Group 1A: 69% lost weight; group 1B: 50% lost weight; Group 2: 25% lost weight 2 yrs: Overall 21 children lost wt; 24 children did not. Children of mothers who decreased BMI/ energy intake more successful
Flodmark et al. (1993)	Child obesity treatment	94 obese children 10-11 years	Both groups: parent + child together Group 1 (N=19): Diet counseling Group 2 (N=25): Diet counseling + family therapy	Group 3 (N=50): No treatment	14-18 months: 1 every 3 months, then every 6 months 1 year follow-up	18 months: Group 2 children had the smallest increase in BMI 1 yr follow-up: Group 2 children had smaller BMIs than group 3, but no difference from group 1
Ray et al. (1994)	Child obesity treatment	1128 overweight children (Singapore) 3-6 years	Group 1(N=1128): Diet, exercise, and behavioral change counseling	None	1 year (2 monthly + 2 every 3 months)	40% reduced their obesity status and 20% reached normal weight
Golan et al. (1998)	Child obesity treatment	60 obese children (Israel) 6-11 years	Group 1 (N=15): Parent alone	Group 2 (N=15): Child alone	Group 1: 14 sessions (4 weekly + 4 biweekly + 6 every 6 wks; in last 6 sessions, parents and children together for 5 short sessions in between main sessions) Group 2: 30 sessions (8	Weight reduction and behavioral changes greater for group 1

					weekly + 22 biweekly)	
Simell et al. (2000)	Obesity prevention through cardiovascular disease risk reduction	843 children 7-36 months	Group 1 (N=426): Parent alone counseled on atherosclerotic risk factors	Group 2 (N=417): Parent alone given basic routine health education	3 years (visits at 7,8,10,13,15,18,21,24,30, 36 months)	Group 1 consumed significantly less saturated fat; serum cholesterol, LDL, and HSL were lower in group 1; no effect on height/weight in group 1
Epstein et al. (2001)	Obesity prevention	30 non-obese children 6-11 years	Both groups: parent + child together Group 1 Increase fruit & vegetables (N=15): Group 2 Decrease high-fat/high-sugar foods (N=15):	None	6 months + 1 year follow up (8 weekly + 4 biweekly + 2 monthly)	12 month follow up: Decrease in high-fat/high-sugar foods significant while increase in fruits & vegetables non-significant for both groups No changes in child % overweight
Harvey-Berino & Rourke (2003)	Obesity prevention	40 non-obese children 9 months – 3 years (Native American, low income)	Group 1 Obesity prevention plus parenting support (N=20): Parent alone	Group 2 Parenting support (N=20) Parent alone	16-weeks	No significant differences in mother or child weight over time or between groups. Trend for decrease in child weight for height in group 1. Energy intake reduction greater in group1

child obesity interventions that involve parents as agents of change. Of the studies that did not involve concurrent parent weight loss, it was found that education of parents exclusively (Golan et al. 1998) or of parents and children separately (Brownell et al. 1983, Nuutinen 1991, Wadden et al. 1990) was more effective than treatment of the child alone. Programs that included problem-solving (Graves et al. 1988), behavioral modification (Graves et al. 1988), training in parenting skills (Israel et al. 1985), and family therapy (Flodmark et al. 1993) were more powerful than conventional diet/exercise instruction.

Evidence for the effectiveness of educating the parent, as opposed to the child exclusively, is provided by the following investigations. In a study of 42 obese 12-16 year olds, Brownell et al. (1983) divided children into three treatment groups with varying levels of parental involvement: 1) mother and child attended separately, 2) mother and child met together, and 3) child alone attended treatment sessions. Children in the mother-child separately group lost more weight at the end of treatment and at follow-up than the other two groups. Wadden et al. (1990) conducted a weight loss intervention in 36 obese African American females, 12-16 years old. A positive correlation was found between number of sessions attended by the mother and subsequent weight loss in her daughter.

In a study by Nuutinen (1991) conducted in 32 obese children 6-16 years, the effect of individualized treatment versus group treatment in mother-child pairs who attended sessions together was compared to a child-alone conventional school setting. Regardless of whether the treatment was individualized or in a group, children in the parent-child groups lost more weight than the child treated alone. Finally, Golan et al. (1998) studied 60 obese 6-11 year olds receiving treatment for obesity and concluded that child weight loss was greater in the parent-alone than child-alone group, thus providing additional support for the importance of involving the mother in child obesity treatments.

The effectiveness of additional components to the standard family-based child obesity treatments has been examined in three studies. Israel et al. (1985) compared weight loss in 33 overweight children 8-12 years old. Parent-child pairs were divided into two groups: 1) attended sessions on behavioral weight reduction or 2) attended sessions on behavioral weight reduction plus special training in parenting an obese child. At the end of the 8-week treatment children in both groups lost comparable amounts of weight, but those whose parents also received training in parenting, maintained a slower rate of weight gain. In 1988 Graves et al. evaluated the effects of three child obesity treatment programs given to the parent and child together: 1) behavioral weight reduction, 2) behavioral weight reduction plus problem-solving exercises, and 3) instruction on diet and exercise only (no behavior modification or problem-solving). At the end of the 8-week treatment, children in the behavioral weight reduction groups lost more weight than those in the diet and exercise alone instruction group; the addition of problem-solving exercises increased the amount of weight lost. At the 6-month follow-up weight loss was maintained in children in the behavioral weight reduction + problem solving group, whereas those in the other two groups gained weight. In a study of 94 obese, 10-11 year old children, Flodmark et al. (1993) divided parent-child pairs into three groups: 1) diet counseling, 2) diet counseling plus family therapy, and 3) controls. The goal of the family therapy was to improve family functioning by intervening at the family level versus the individual level. Weight loss was found to be greater in children who attended sessions with parents on diet counseling and family therapy versus diet counseling alone.

Weight Loss in Mothers as a Role Model for Change in Children

Most parents of overweight children do not believe that their child is overweight or that this excess weight poses a significant health threat. For example, 79% of mothers with overweight children failed to perceive their child as overweight (Serdula et al. 1993). In a survey conducted in WIC clinics, healthcare professionals also identified several additional barriers among low-income mothers. They believed that mothers were focused on dealing with daily stresses; used food to cope and as a tool in parenting; had difficulty setting limits surrounding eating in their children; and did not perceive their overweight children as overweight (Chamberlin et al. 2002). It has been our experience that low-income mothers may not be motivated to come to educational programs designed solely to help their child, but they are more likely to come to classes to lose weight for themselves. Thus, this research used weight loss classes for the mothers as a vehicle for an educational program that promoted healthful changes for the child.

Two studies were found in the literature that involved weight loss in mothers for the prevention of obesity in children (Epstein et al. 2001; Harvey-Berino and Rourke 2003); however, these were not conducted in the same population as this research. The Epstein et al. study included 30 at-risk, non-obese 6-11 year olds with at least one obese parent. The 6-month intervention was delivered to both parents and children who were assigned to the following groups: (1) increase fruit and vegetables or (2) decrease high-fat/high-sugar group. At 1-year, anthropometric and dietary changes were measured and were found to be more pronounced in the parents than the children. For example, in both groups the % of overweight declined in parents, but remained stable in children over the course of the program. Also, high-fat/high-sugar foods decreased for all groups; however the increase in fruits and vegetables was only significant in the mothers in group 1. It was concluded that the messages of group 1 were more effective than those of group 2 for affecting the diet and weight of the families.

Harvey-Berino and Rourke (2003) administered a 16-week obesity prevention program to overweight Native American parents of children 9-months to 3-years old (n=40) who were participating in WIC. Parents were divided into two instructional groups: (1) parenting support or (2) obesity prevention plus parenting support. The "obesity prevention" component emphasized skills for improving eating and exercise behaviors in children. Parents in both groups slightly decreased their weight, although this was not statistically significant. Weight-for-height z-scores and energy intake of the children in group 2 declined as compared to a slight increase in group 1 (p=0.06).

Other researchers have implemented interventions for the prevention and treatment of obesity in young children without weight loss in the mother (Müeller et al. 2001, Pisacano et al. 1978, Ray et al. 1994, Simell et al. 2000; Williams et al. 2002). The initial results of a two-part school- and family-based obesity prevention program for 5-7 year olds (n=92) was presented by Müeller et al. (2001). Only the results of the family counseling sessions (3-5 home visits by a nutritionist) will be discussed, as school-based interventions are not the focus of this research. Three months after the intervention, consumption of fruits, vegetables, and low-fat foods and physical activity increased, and television viewing declined, in the children. Changes in anthropometrics of these children were not provided.

Pisacano et al. (1978) conducted an obesity prevention program in 80 infants at 3-4 months of age. Infants were divided into two groups, and the diets were initiated at 3 months. In group 1, parents were instructed on a "prudent diet" while those in the comparison group received no instruction. A weight percentile one standard deviation greater than height was considered overweight. By age 3, the prevalence of overweight was 1.28% in the prudent diet group versus 25.5% in group 2.

In a study by Ray et al. (1994), parents and overweight children 3-6 years old in Singapore (n=1128) were provided with counseling sessions on diet, exercise, and behavioral changes for the treatment of child obesity. The subjects served as their own controls. At 1-year follow up, 40% reduced their overweight status and 20% became normal weight. Diet and activity parameters were not assessed in this study.

The Special Turku Coronary Risk Factor Intervention Project for Babies (STRIP) was designed to decrease exposure to cardiovascular risk factors in 7-36 month olds (n=843) (Simell et al. 2000). Parents of children in the intervention group received counseling on a heart healthy diet for their child. This diet emphasized limiting fat intake to 30-35% of energy with a 1:1:1 ratio of poly-, mono-, and saturated fats; limited use of salt; replacement of high saturated fat foods with lower fat items; increased consumption of vegetables; and discouraged use of candy and simple sugars. Intervention children consumed less saturated fat and decreased cholesterol 3-6% more than the control children. No negative effects on child growth or intake of other nutrients were observed.

An additional study was designed to prevent obesity in 2-5 year old children via intervention with the food service staff at Head Start centers (Williams et al. 2002). Employees were instructed on preparing meals that were <30% energy from fat and <10% from saturated fat. Saturated fat intake of the children and the school meals decreased significantly at 1- and 2-year measurements. Energy intake and consumption of other nutrients remained adequate.

Other interventions have targeted parents for weight loss and role modeling, in combination with obesity treatments in older children (Epstein et al. 1981, Epstein et al. 1984, Kirschenbaum et al. 1984, Raynor et al. 2002). Epstein et al. (1981) divided 76 obese 6-12 year old children and their parents into three groups: 1) parent and child both targeted for weight loss, 2) child targeted for weight loss or 3) non-specific target (neither targeted for weight loss). All three treatment groups were given information on diet, exercise, and behavior modification (self-monitoring, modeling, praising, contracting). At the end of the 8-month treatment, weight loss in children was similar for all three groups. Weight loss in parents was greatest in the parent/child weight loss group. At 21-month follow-up, a greater proportion of children in the parent/child weight loss group were non-obese (37%), as compared to the child weight loss and non-specific target groups (24% and 20%, respectively). All (100%) of the newly non-obese children in the parent/child weight loss group maintained their non-obese status, as compared to 30% and 33% of those in the child weight loss and non-specific target groups, respectively. At 5 and 10-year follow-ups, child weight loss was greater in the parent/child weight loss group than the other two groups. Also, obese children of non-obese parents maintained their weight loss better than those with obese parents (Epstein et al. 1987, Epstein et al. 1990a).

Epstein et al. (1984) divided 53 obese, 8-12 year old children and their overweight parents into three groups: 1) parent and child both targeted for weight loss with diet instruction, 2) parent and child both targeted for weight loss with diet and lifestyle exercise instruction, and 3) controls. The treatment groups were given instruction on nutrition, exercise, stimulus control, food purchase, self-control, relapse prevention, and label reading, but the diet plus exercise groups received a more intensive lifestyle change exercise program. At end of the 6-month treatment, children in the diet-only group lost more weight than children in the diet and exercise group or controls. In contrast, parents in the diet and exercise group lost more weight than the diet only group and controls. At 1-year follow up, children in both groups had similar weight losses, while parents in the diet and exercise group continued to lose more weight. While this study focuses more on the effects of diet versus diet and exercise instruction on concurrent parent/child weight loss, parent and child weight loss were highly correlated during the first 6-months of treatment.

In a study by Kirschenbaum et al. (1984) 40 overweight, 9-13 year old children were assigned into three groups: 1) parent and child both targeted for weight loss, 2) child targeted for weight loss and 3) controls. Both treatment groups received a behavioral treatment program including self-monitoring, exercise instruction, nutrition education, stimulus control, meal planning, rewards, and coping techniques. In the parent/child weight loss group, both parent and child attended sessions together, while in the child only group, children attended sessions alone and brought the lessons home to their parents. At the end of the 9-week treatment, children in both treatment groups lost weight, with the child-only group losing more. However, by 1-year, children in the parent/child weight loss group continued to lose weight, while children in the child-only group showed a trend in weight gain. Mothers in the parent-child group lost weight, while those in the child-only and control groups gained.

Raynor et al. (2002) conducted an obesity treatment program in 24 families with an overweight/obese 8- to 12-year old. Families were assigned to one of two treatments: (1) group plus individual sessions or (2) groups sessions only. Both groups were counseled on diet, activity, and behavior change for weight control. Sessions lasted for 20 weeks with follow up visits at 6-months and 1-year. At both follow up visits, percent overweight and energy intake and servings of low-nutrient density foods declined in the children.

In 1992b Nuutinen and Knip conducted a follow-up study of 32 obese, children 6-16 years old who received a weight loss intervention. The children were divided into two treatment groups: 1) individual and group sessions involving the parent and child together and 2) conventional school setting with the child alone. The immediate post-treatment results of this study were described previously (see page 15). Although parents in this study were not targeted for weight loss, two-year follow up data of the obese children found that children who were more successful at losing weight had mothers who also lost weight and decreased their energy intake (Nuutinen and Knip 1992b). The conclusion based on the above studies is that the involvement of the mother in weight loss for the child appears to be more effective than just treating the child alone.

Yet two studies did not find a clear, positive impact of parental weight loss on weight loss in children. In a study by Epstein et al. (1986), 41 obese 8-12 year old children were divided into: 1) obese children and obese parents targeted for weight reduction and 2) obese children targeted for weight reduction with non-obese parents. Children in both groups lost weight at 6 months; but at 1 year, obese children with non-obese parents (who were not losing weight) lost more weight than obese children with obese parents (who were trying to lose weight). This study does not disprove the validity of using an overweight mother as an agent of change because the outcome appears to be confounded by some of the parents being obese, while others were not. Thus, it is unclear if this result was due to genetics or the environment.

The second study was by Israel et al. (1990) who conducted a weight loss intervention in 40 obese children of a similar age group (9-13 years). After 4 weeks of intervention, parents were paired with their child as: 1) the "weight loss group," both wanting to lose weight, and 2) the "helper group," obese children with parents who helped the child, but did not attempt to lose weight themselves. Children whose parents were also trying to lose weight were more successful at 8 weeks; by week 26, significant weight loss was seen only in children in the helper group; and at 1 year, children in both groups regained comparable amounts of weight. Whether or not success would have been greater if the intervention was initiated at an earlier age is unknown; but it is well documented that obesity becomes more difficult to treat as a child grows older (Dietz 1999).

Behavioral Techniques

In reviewing child obesity treatments, behavioral treatment techniques were found to be more effective than diet and exercise instruction alone. The most successful interventions were based on major concepts in the Social Cognitive Theory (Brownell and Wadden 1984, Epstein and Squires 1988, Haddock et al. 1994) and included the use of reinforcements (Epstein et al. 1990a, 1994); praise (Epstein et al. 1990a); goal setting and contracts (Robinson 1999); self-monitoring (Coates et al. 1982, Epstein et al. 1990a); group format with individualized (Robinson 1999) and parent involvement (Epstein et al. 1994); frequent sessions and long treatment duration (Brownell and Jeffrey 1987); a lifestyle physical activity program with reduction of sedentary activities (Epstein et al. 2000, Sothern 2001); an easy to understand diet lower in calories (Epstein et al. 1990a, Robinson 1999); changes in the home environment (Golan and Weizman 2001); improvement in parenting skills (Israel et al. 1985); and relapse prevention (Robinson 1999). The most effective environments for preventing obesity in childhood are supportive, with education on healthful eating and promotion of opportunities for physical activity (Berg et al. 2003). The above behavioral techniques were incorporated into the intervention in this research, as well as additional components of diet and physical activity.

Dietary Interventions

A second component of the intervention was diet modification. Diets for the prevention and treatment of child obesity should promote healthful foods and be well-balanced and based on the Food Guide Pyramid (Barlow and Dietz 1998, Robinson 1999) and Dietary Guidelines (Dwyer 2000). The most effective diets are simple and easy to understand (Robinson 1999). For example, the "Stoplight Diet" for children has been found to be useful (Barlow and Dietz 1998, Robinson 1999). In this diet planning tool, foods are in grouped into colors by calorie content, with green, yellow, and red foods indicating low-, medium-, and high-calorie foods, respectively. Children are encouraged to eat the most from foods in the green group, slightly less from foods in the yellow group, and the least from foods in the red group (Epstein and Squires 1988). Although we did not use the "Stoplight Diet," we used the Food Guide Pyramid for Children (Hot Food Facts for Cool Kids, Stein and Sherman 1999) in our interventions. In this diet-planning tool, the high-calorie foods are highlighted in yellow at the tip of the pyramid, and parents are instructed that yellow means caution and to serve foods from the tip of the pyramid in small amounts.

Dietary instruction for the mothers also addressed identification of specific high-calorie foods at home, school, daycare and restaurants (Barlow and Dietz 1998, Dietz and Gortmaker 2001) and high-calorie food preparation techniques (Barlow and Dietz 1998, Brownell et al. 1985), as well as appropriate substitution for these foods. For families of overweight or obese children, diet modifications included counting calories and creating a calorie deficit (Barlow and Dietz 1998, Robinson 1999), reducing fat intake (Dietz 1999, Robinson 1999), increasing fiber intake (Robinson 1999), and reducing portion sizes (Dietz 1999) until children grew into their weight. Small and permanent (Barlow and Dietz 1998) changes were emphasized, focusing on two or three changes at a time

(Barlow and Dietz 1998). In addition, our study promoted a diet rich in fruits and vegetables in order to increase preference for those tastes (Robinson 1999) and reduce obesity (Dietz and Gortmaker 2001, Epstein et al. 2001). Researchers have demonstrated that the focus should be on promoting healthy foods, not restricting access to less nutritious foods (Dietz and Gortmaker 2001). Since the use of low-fat or diet versions of foods for children is not recommended, as continued exposure to these foods may enhance their appeal (Satter 2000), a moderate fat diet (30-40% of energy from fat) with low- and high-fat foods balanced in meals was promoted. Other successful strategies used with overweight children include limiting times, places, and activities associated with eating, slowing the rate of eating, and leaving food on the plate (Brownell et al. 1985).

The role of fat in the diets of children has been debated. Proponents of fat-restricted diets for children argue that low-fat diets for children are safe, may decrease the development of atherosclerosis, and can train children to like low-fat foods (Olson 2000). Opponents of low-fat diets for children argue that there is little evidence that high-fat diets in children cause atherosclerotic development and that fat-restriction may compromise the growth and health of children, lead them to develop an aversion to low-fat foods, or disrupt their ability to self-regulate food intake (Olson 2000). Emphasizing fat restriction in children may also confuse or scare the child away from foods (Satter 2000). In addition, it is argued that children are not developmentally capable of choosing between high- and low-fat foods (Satter 2000).

The detrimental effects of low-fat diets have been seen primarily in studies involving very low-fat diets (<20% of energy from fat) (Dwyer 2000). Emphasis should be placed on saturated fat and cholesterol contents of children's diets instead of total fat (Dwyer 2000). In a given meal, high-fat foods should be balanced with lower-fat foods so that the child can select from a variety of high- and low-fat foods. This technique will ensure that children will learn to like a variety of foods and should allow for a diet moderate in total fat, saturated fat, and cholesterol (Satter 2000). Lytle (2000) suggests that low-fat diets for children do not have to be restrictive; instead they should be based on the Food Guide Pyramid, with some substitutions for high-calorie foods. In the intervention we incorporated the above strategies.

Physical Activity Interventions

Physical activity was a third component of the intervention. Klesges et al. (1995) reported that physical activity was protective against BMI increases in a 3-year longitudinal study of 145 preschool children. Mothers who are physically active also may act as role models for their child (Sallis et al. 1996). Parental influences are postulated to act through a combination of modeling, prompting, and reinforcement (Bouchard 2000). In a study of 129 obese children and their parents, Fogelholm et al. (1999) found that vigorous activity levels in the mother were positively correlated with their son's (but not daughter's) activity levels. A stronger association was seen between both parent and child inactivity, than with vigorous activity. This study illustrates the importance of decreasing sedentary behaviors in parents, as well as in children. The need for physical activity modeling is especially critical for minority children as African-Americans and Mexican-Americans are reported to be less active than Caucasians (Kann et al. 1998, Pivarnik et al. 1995, Trowbridge et al. 1997). Thus, our interventions with minority population groups emphasized increased physical activity.

Effective interventions have been designed to promote physical activity in the family. The Child and Adolescent Trial for Cardiovascular Health (CATCH) study promoted a physical activity curriculum at schools for 3rd - 5th grade students, along with parental involvement at home. Self-reported daily vigorous activity was higher with intervention than without (58.6 vs. 46.5 minutes, p<.003) (McKenzie et al. 1996). This large-scale study of multi-ethnic students (n=5106) shows that physical activity levels can be successfully increased in at risk-populations. Epstein et al. (2000) observed that in a family-based intervention for treating pediatric obesity, both decreasing sedentary behaviors and increasing physical activity were associated with significant decreases in percent overweight and improvements in aerobic fitness. In a study by Bosch et al. (2000) positive results were obtained in an educational physical activity intervention with low-income Hispanic and Caucasian families with preschoolers. Mothers reported increases in the frequency that their families were active together, took their child outside, played with their child, or encouraged their child to be active (Bosch et al. 2000).

It is well established that major determinants of low physical activity levels of children are television viewing and sitting time (Bratteby et al. 1997). Epidemiological studies have found that hours of television viewing are correlated with obesity in children (Gortmaker et al. 1996, Maffeis et al. 1998) and reducing TV viewing may help prevent adiposity (Robinson 1999). In 3rd and 4th grade children who decreased television viewing time, beneficial changes in anthropometrics and declines in sedentary behaviors were observed (Robinson 1999). A study of 66 mothers of children 3-8 years old reported that television viewing hours were associated positively with children's caloric intake (Taras et al. 1989). In 6^{th} grade children, television viewing time also was related positively to children's skinfold measurements and BMI, even after other variables were controlled (Klesges et al. 1993). Epstein et al. (2000) suggests that targeting a decrease in sedentary behaviors is more effective than increasing activity for weight loss and improvements in aerobic fitness. Thus, our studies will focus on the reduction of inactive behaviors in mothers and their children (television viewing and computer use) and the promotion of lifestyle activities (walking to school, playing sports, doing labor-intensive chores) (Epstein et al. 2000).

CORRELATES OF OBESITY IN CHILDREN

The causes of overweight in children are complex and difficult to identify due to the influence of confounding factors. However, they are all related to poor diet and/or lack of activity, coupled with genetic pre-dispositions. It is believed that the contribution of environmental factors to child obesity may be as much as 80% (Sothern and Gordon 2003).

Non-Modifiable Factors

A variety of factors that cannot be modified by interventions appear to contribute to childhood obesity. These include family history of diabetes, infant birth weight, ethnicity, single-mother families, lower maternal education and socioeconomic status, method of infant feeding, and age of introduction of solid foods. Family history of diabetes (Basit et al. 2003, Giampietro et al. 2002) is a significant correlate of child obesity in older children. Infant birth weight (Gillman et al. 2003, Hediger et al. 1999, Locard et al. 1992, Sherman et al 1995), Hispanic (Hediger et al. 2001, Sherman et al. 1995) or African American ethnicity (Strauss and Knight 1999), single-mother families (Gerald et al. 1994, Sherman et al. 1995, Strauss and Knight 1999), and lower maternal education (Baughcum et al. 2000, Moussa et al. 1994, Strauss and Knight 1999) appear to be associated with child obesity at even younger ages.

Socioeconomic status is another non-modifiable factor that may contribute to child obesity. Some studies report an increased risk of child obesity with lower SES (Liu et al. 2002; Strauss and Knight 1999), even within low-income populations (Sherman et al. 1995), while others found a lack of association (De Spiegelaere et al. 1998) or a differential effect depending upon the child's age (Garn and Clark 1975). One confounding factor in the above studies is that differences in the ages of the children measured may greatly influence the results. For example, Garn and Clark (1975) reported that obesity in early childhood was associated with higher SES, but in adolescence, obesity was associated with low SES.

Other non-modifiable factors that may be related to a child's weight are the method of infant feeding (Fisher et al. 2000, Kramer et al. 1985, Maffeis 1999, von Kries et al. 2000) and age of introduction of solid foods (Kramer et al. 1985, Parsons et al. 1999, Tanasescu et al. 2000). Breastfed babies have been shown to have smaller weight-for-length z-scores than formula fed infants between 4 and 18 months (Dewey et al. 1992), but long-term benefits of breastfeeding on child weight remain unclear. Longer duration of breastfeeding was found to be protective against overweight particularly in non-Hispanic white, low-income 4-year olds (Grummer-Strawn et al. 2004). In older children (5-6 years), Von Kries et al. (2000) found a protective effect breastfeeding on obesity, and Kramer et al. (1985) also reported benefits of both breastfeeding and delayed introduction of solid foods on child weight. In contrast, others found the opposite. Fisher et al. (2000) reported higher energy intakes in toddlers (18 months) who were breastfed for 1 year. In a retrospective study of 3 to 5 year olds, there was no clear effect of duration of breastfeeding on child weight-for-height; however, delayed introduction of solid foods was protective against child overweight (Hediger et al. 2001). Therefore, the influence of breastfeeding and age of introduction of solid foods on child obesity is unclear. It is recognized that these physical and demographic influences will not be altered by the interventions in this study, but their relationship to child weight will be considered.

Modifiable Factors

A number of factors can be changed via intervention. These include maternal obesity; child and parent inactivity; high fat intake; low fruit, vegetable, and dairy intake; and frequency of restaurant food consumption. Maternal obesity (Burke et al. 2001, Crawford and Shapiro 1991, Dowda et al. 2001, Gyovai et al. 2003, Hediger et al. 2001, Sherman et al. 1995, Stettler et al. 2002, Strauss and Knight 1999, Whitaker et al. 2000) is a consistent predictor of child overweight/obesity at various ages during childhood.

Physical activity also may confer a protective effect on child weight and/or body fatness. A study by Klesges et al. (1995) in 146 preschool children followed over a 3-year period found that high baseline aerobic activity and increases in leisure time activity from year 2 to 3 were associated with decreases in child BMI. In a longitudinal study of 97 healthy weight children, those with lower levels of physical activity in preschool gained more body fat by age 6-7 years than those who were more active, even when controlling for age, TV viewing, energy intake, triceps skin folds, and parental BMI (Moore et al. 1995). Crawford and Shapiro (1991) also noted a weak inverse correlation between child activity and obesity beginning as early as 6 months of age. In contrast, Eck et al. (1992) reported that children with an overweight parent(s) gained more weight over 1-year, but only had marginally lower activity levels than other children without an overweight parent(s). Robertson et al. (1999) also did not find any differences in the physical activity levels of children who had significant increases in their skin folds versus those who did not from the ages of 3 – 7 years. Thus, the relationship between child weight and activity remains controversial.

Parent inactivity has also been shown to be a strong predictor of child inactivity which may contribute to child obesity (Fogelholm et al. 1999). Moore et al. (1991) reported that parent and child activity levels were related in 4-7 year olds. Parental inactivity was also a predictor of child inactivity in a study of 7-12 year olds (Fogelholm et al. 1999). In contrast, parental modeling and encouragement of activity were not related to child activity in a study of 3-5 year olds by Trost et al. (2003), and parental activity was unrelated to child activity level in 5-year-old girls (Davison and Birch 2001). Thus, the impact of parental activity on child's activity and subsequent obesity is debatable.

Several studies show a positive relationship between total fat intake and percent of energy from fat and child fatness in preschool (Newby et al. 2003; Fisher and Birch 1995; Nguyen et al. 1996; Klesges et al. 1995; Robertson et al. 1999) and school age children (Tucker et al. 1997; Gazzaniga and Burns 1993; Nguyen et al. 1996; Robertson et al. 1999; Davison and Birch 2001). Low dairy intake has also been implicated (i.e. lack of milk, yogurt, and cheese) (Tanasescu et al. 2000). Also, low fruit and vegetable intake is believed to be associated with child obesity, and it is well known that promoting a diet rich in fruits and vegetables is an effective strategy to reduce obesity in families (Epstein et al. 2001). In older children, Field et al. (2003) found vegetable intake inversely correlated with changes in BMI z-score in boys 9-14 yrs; however, this effect disappeared when adjusted for total caloric intake (Field et al. 2003).

Fast food consumption has also been cited as a risk factor for obesity, presumably due to its effect on diet quality. In a study of 6212 children and adolescents ages 4-19 years, Bowman et al. (2004) found that children who ate fast food consumed more calories, energy/gram of food, carbohydrates, added sugars, sugar sweetened beverages and less fiber, milk, fruits, and non-starchy vegetables. Fast food consumption has been linked to body fatness in adults, while controlling for age, sex, physical activity and other confounders (McCrory et al. 1999), and to change in BMI in adolescent girls (Thompson et al. 2004).

Nutrition Knowledge and Attitudes of Mothers

Nutrition knowledge and attitudes of the mother will be assessed to determine their relative influence on the child's weight. Lissau et al. (1993) reported that lack of maternal knowledge increased the likelihood that the child would be overweight. This may be particularly true in low-income and minority mothers of elementary school children who may lack fundamental nutrition knowledge related to the health of their families (Ivanovic et al. 1997, Touliatos et al. 1984). Baughcum et al. (1998) found that mothers of 1-3 year old children who receive WIC, rely predominantly on their mothers for nutrition information, and this information may be false. Sherman et al. (1995) who reported that lack of nutrition knowledge increased the likelihood that the children would be overweight in 377 Mexican American and Anglo mothers of preschool children (3-5 years) participating in WIC. In a study of children 9-11 years, Gibson et al. (1998) found that maternal nutrition knowledge was related to higher fruit consumption in their children.

NUTRITION KNOWLEDGE OF MOTHERS AND WEIGHT LOSS

Lack of knowledge may contribute to the higher rates of obesity and poorer diet quality in the economically disadvantaged. For example, low-income caretakers with children did not read food labels or have low-fat, eating habits as readily as their higher income counterparts (Morton and Guthrie 1997). Kruger and Gericke (2003) also found that low-income mothers had suboptimal knowledge of nutrition and adhered to cultural food practices that adversely affected the diets of their babies.

Studies of the Enhancement of Nutrition Knowledge

Two recent studies were designed to improve the nutrition education of mothers with preschool children; however weight loss in the mother was not an outcome (Campbell et al. 2004, Ilett and Freeman 2004). Campbell et al. (2004) administered a nutrition education CD-ROM to 307 WIC mothers of young children. Intervention mothers demonstrated significant increases in low-fat and infant feeding knowledge at the 1-2 month follow-up, as compared to controls. However, despite these gains, dietary intake of the two groups did not differ. In a study by Ilett and Freeman (2004), maternal dietary knowledge and her child's intake improved following a health education program in 26 mothers of anemic toddlers.

Enhanced nutrition knowledge is important for facilitating weight reduction, as greater nutrition knowledge has been associated with better weight loss following a nutrition education intervention (Agurs-Collins et al. 1997, Bruno et al. 1983, Domel et al. 1992a, Domel et al. 1992b, Jeffery and Wing 1995, Rhodes et al. 1996). Of these, only two studies were conducted in low-income women (Domel et al. 1992a, Domel et al. 1992b).

In contrast, others have not documented weight loss with improvements in nutrition knowledge. These interventions included dietary fat modification in 351 low-income participants (Howard-Pitney 1997), worksite cholesterol reduction in 272 men (Braeckman et al. 1999), a heart healthy initiative in 434 low-literate Latino adults (Elder et al. 2000), and fat and Food Guide Pyramid education for 365 Samoans (Bell et al. 2001). Other investigators have reported that knowledge was not related to better weight control, as obese subjects had similar or higher scores on nutrition tests (Allison et al. 1995, Burns et al. 1987). Thus, cognition may not always lead to better weight management.

Demographic and Social Disparities in Nutrition Knowledge

In addition, demographic disparities in nutrition knowledge are apparent, and interventions should be designed to reduce these inequities. For example, higher scores have been documented in Caucasians versus other ethnicities (Sapp and Jensen 1997, Sherman et al. 1995, Winkleby et al. 1994); and in those with more formal education (Boulanger et al. 2002, Parmenter et al. 2000, Sapp and Jensen 1997), higher income (Harnack et al. 1998, Morton and Guthrie 1997, Parmenter et al. 2000), English-speaking (Boulanger et al. 2002), and in households with fewer children (Boulanger et al. 2002, Ivanovic et al 1997, Morton and Guthrie 1997). Breastfeeding has been associated with greater (Dubois and Girard 2003), and skipping meals with lower, levels of formal education (Levy et al. 1993), but neither have been linked to nutrition knowledge.

An additional hypothesis tested in this study was the relationship of mother's nutrition knowledge to her child's weight-for-height. Sherman et al. (1995) reported that low-income mothers who had greater nutrition knowledge were less likely to have an obese 3-5 year old child. Thus, improving the nutrition knowledge of the mother may help prevent obesity in the child.

SUMMARY

The epidemic of adult obesity is developing in young children, and effective strategies for prevention and treatment are necessary. Low-income and minority populations are at high-risk for excess weight and warrant the greatest need for intervention. Weight loss in mothers is one approach for facilitating diet and activity changes in children. Mothers are the primary providers of food in the home and their food preferences, nutrient intakes, and weight frequently are related to their child's.

Thus, mothers make ideal targets for interventions, and mothers who make alterations in their food choices should make comparable modifications in the foods offered to her child. In addition, determination of the relative contribution of physical, demographic, dietary, and psychosocial factors to overweight/obesity in 1-3 year old children with overweight/obese mothers is needed. Potential applications of this research will include: the development of a child food frequency questionnaire for dietary assessment, intervention for the promotion of healthful diet and activity in families, identification of risk factors for excess child weight-for-height, and quantification of nutrition knowledge levels in overweight/obese, low-income mothers. The information gained in this research can be used by health professionals working in the community setting to improve the health of mothers and children who are economically disadvantaged.

Thus, the overall goal of this project is to develop/test an educational weight loss intervention for mothers of young children who will act as agents of change for their child's diet and activity. Additionally, a FFQ for assessing food choices in 1-3 year olds will be developed and psychometrically tested, factors related to greater weight-for-height in these children will be examined, and the impact on nutrition knowledge on weight loss in low-income mothers evaluated.

All four studies utilized subsets of data from one larger sample (n=191) of low-income, tri-ethnic mothers and children. Study 1 included overweight/obese and healthy weight mothers completing diet records and a FFQ for their 1-3 year old child (n=77). Study 2 consisted of non-breastfeeding, overweight/obese mothers of 1-3 year olds who participated in the weight loss intervention (n=91). Study 3 was comprised of overweight/obese mothers of 1-3 year olds who completed initial baseline anthropometrics and questionnaires for themselves and their child (n=101). Subjects for study 4 encompassed overweight/obese mothers of children 8-month to 12-years olds who were enrolled in either the weight loss intervention for mothers of 8-month to 4-year olds or a similar program delivered to mothers of elementary school age children (n=141). All subjects were African American, Hispanic, or Caucasian mothers ≥ 18 years of age, had a combined family income < 200% of the federal poverty level, and were literate in English (or Spanish in study 4 only).

Chapter 2: Relative Validity and Reliability of a Food Frequency Questionnaire for a Tri-Ethnic Population of 1-3 Year Old Children from Low-Income Families

ABSTRACT

Objective: To develop and validate a food frequency questionnaire (FFQ) for low-income, 1-3 year old Hispanic, African American, and Caucasian children.

Design: A convenience sample of low-income mothers provided dietary data for their child via food frequency questionnaires and 3-day diet records.

Subjects/setting: Participants (n=77) were recruited from the Special Supplemental Program for Women Infants and Children (WIC) clinics and public health clinics. All subjects were Hispanic, African American, or Caucasian mothers of children 1 – 3 years old, ≥ 18 years of age, income < 200% of the federal poverty level, and were literate in English.

Statistical analyses performed: Wilcoxen signed-ranks tests were used for comparisons of food group servings on time 1 and time 2 FFQs and to examine differences in food group servings between the FFQ and diet records. Spearman correlations were calculated to assess test-retest reliability and the relative validity. Contingency tables were used to determine the degree of association between the FFQ and diet records.

Results: Reliability correlations were significant for all nine food categories (x = 0.69), ranging from 0.53 (soups) to 0.84 (non-starchy vegetables). Validity correlations were significant for all food groups (x = 0.41), except starchy vegetables. Thirty six percent of children were classified into the same quartile of food group intake and 78% into the same or adjacent.

Conclusions: The FFQ yielded excellent reliability and acceptable validity and can be used to assess food choices in a tri-ethnic sample of low-income, 1-3 year olds.

INTRODUCTION

The collection of dietary information that reflects the eating habits of young children is challenging. Surrogate sources (i.e. parents, guardians) must be used for obtaining food intake in preschool children (Krall et al. 1988, Samet and Alberg 1998); yet, it is difficult for caregivers to recall foods consumed by their child when they are not present (Baranowski et al. 1991) and the food habits of young children change constantly. One way to compensate for these potential problems is to obtain multiple measures of diet (Frank et al. 1986), such as 24-hour recalls, diet records, and/or food frequency questionnaires (FFQs).

The validity of a mother's report of her child's dietary intake has been established for recalls of a single meal (Eck et al. 1989) and for 24-hour food recalls (Basch et al. 1990, Klesges et al. 1987). However, diet recalls and records capture only a brief period of time; thus, FFQs are important for gathering generalized patterns of food intake (Cade et al. 2002). Although several food frequency questionnaires have been developed for children and adolescents, most are not appropriate for young children. Only three validated questionnaires have assessed food choices in 1-year olds (Blum et al. 1999, Marshall et al. 2003, Parrish et al. 2003), and four others could be used with 2-3 year olds (Blom et al. 1989, Stein et al. 1992, Taylor and Goulding 1998, Treiber et al. 1990). Only two of these have been validated in children from low-income families. These include studies by Stein et al. (1992) in primarily Hispanic 3-4 year olds and by Blum et al. (1999) in Native American and Caucasian 1-year old children. To our knowledge, age-appropriate and culturally-sensitive FFQs have not been validated for Hispanic or African American 1-3 year olds.

The purpose of this study was to develop, test, and validate a food frequency questionnaire to assess foods consumed by 1-3 year olds in a tri-ethnic population of low-income families in the Southwestern U.S. The child FFQ in this study was derived from an adult version that has been previously validated in a sample of Hispanic, African American, and Caucasian low-income mothers from the same area (George et al. 2004). The adult FFQ was modified to include age-appropriate food items and portion sizes that were applicable to 1-3 year old children.

METHODS

Design of Study

The psychometric evaluation of the FFQ was conducted in two groups of low-income tri-ethnic women for reliability (n = 25) and validity (n = 52). All mothers had 1-3 year old children and completed a demographic questionnaire. Height and weight was measured on one occasion and body mass index (BMI, kg/m^2) was calculated. The BMI-for-age (children $\geq$ 2 years) or weight-for-length (children < 2 years) percentile levels were determined using height and weight of the children, according to Kuczmarski et al. (2002).

Subjects in the reliability sample included healthy weight (BMI < 25 kg/m^2) and overweight/obese (BMI $\geq$ 25 kg/m^2) mothers who completed a food frequency questionnaire for their child during a clinic visit. Two weeks later, these mothers were sent the FFQ to fill out a second time to establish test-retest reliability. Mothers returned this form by mail within 3-4 weeks of the first administration. In order to reduce the impact of actual changes in dietary intake on performance of the questionnaire, administration of the second FFQ was given as soon as possible after the first, but not so close that subjects would remember their previous answers. Phone calls were made to encourage prompt reply and to clarify responses to the food frequency questionnaire. Subjects for the validation sample were overweight/obese mothers who completed a 24-hour diet recall, two days of diet records, and a food frequency questionnaire for their child. The 24-hour recall and 2-day diet records were used collectively (3-day diets) as the criterion for which the child FFQ was compared to assess validity.

Subjects

Participants were recruited from doctors' offices, elementary schools, Special Supplemental Program for Women Infants and Children (WIC) clinics, public health settings, and churches. All subjects were African American, Hispanic, or Caucasian mothers of children 1 – 3 years old, ≥ 18 years of age, had a combined family income < 200% of the federal poverty level, and were literate in English. Mothers were informed of the benefits and risks of the study and informed consent was obtained. The Institutional Review Board of the University of Texas at Austin approved the study.

Food Frequency Questionnaire

The initial food frequency questionnaire for 1-3 year old children contained 191 food items including fruits and juices; breakfast foods; vegetables; meat, fish, poultry and mixed dishes; breads, snacks, spreads; dairy products; sweets; and beverages and 19 additional questions on dietary behavior, as well as an open-ended response for any additional foods eaten. The instrument was designed to be completed by the mother for her child, and was based on a semi-quantitative food frequency questionnaire developed and validated for Hispanic, African American, and Caucasians adults (George et al. 2004). It was derived from the Health Habits and History Questionnaire (HHHQ) (Block et al. 1992), but was extensively modified to include ethnic foods, low-fat foods, restaurant/fast foods, functional foods and nutritional supplements. Based on an expert panel review, 35 items considered inappropriate or infrequently consumed by children were deleted from the adult version, and 29 foods were added to reflect more age-appropriate foods and items from previously validated questionnaires (Block et al. 1992, Gardner et al. 1991, George et al. 2004). Food items were listed as whole, chopped, strained, or mashed forms in alphabetical order within food groups similar in nutrient content.

The format for the frequency section of the questionnaire included nine response options identical to the HHHQ, ranging from "never or < once per month" to "2 + servings per day." Serving size categories included small, medium, large, and extra large. A child's medium serving size was based on portion sizes recommended in Trahms and Pipes (1997) and were roughly one-third to one-half the serving sizes recommended in the Food Guide Pyramid for Young Children, which states that "four- to 6-year olds can eat these serving sizes…offer 2- to 3-year olds less, except for milk" (US Department of Agriculture 1999). Instructions stated that a small serving was half the medium serving; a large, one and a half times the medium serving; and an extra large, two times the medium serving size provided.

The food frequency questionnaire responses were entered into the Statistical Package for the Social Sciences program (SPSS 11.5, Chicago, IL, 2003) and checked by a registered dietitian to ensure accuracy. The nine frequency response options were recoded into fractions of servings per day (0, 0.033, 0.083, 0.133, 0.267, 0.467, 0.73, 1 or 2) and the serving size categories recoded into multiples of a medium serving size (1/2, 1, 1 ½, or 2 times the medium size). Servings per day of the food items were computed by multiplying the number of servings per day by the portion size for the food. Foods were grouped into nine categories based on similarity of nutrient content, as presented in Tables 2.1-2.3.

24-Hour Food Recalls and 2-Day Diet Records

Mothers were administered a 24-hour food recall of their child's intake by a registered dietitian who used household measures and food models. Subjects were instructed on portion sizes, given measuring cups and spoons, and asked to record two additional days of diet, including one weekend day. For foods eaten away from home, parents were asked to contact the caregiver for information. All records were reviewed by a dietitian and clarified to ensure accuracy of portion sizes, preparation methods, type/brand of foods eaten, and completeness.

Transposition of Foods and Amounts from Diet Records

Foods from both the 24-hour recall and food records are collectively referred to as diet records; others have used this technique (Block et al. 1992, George et al. 2004, Patterson et al. 1999). A registered dietitian abstracted foods from the diet records into servings per day of corresponding foods on the FFQ. Mixed dishes were broken down and tallied both as individual foods, according to typical recipes, and as mixed dishes to evaluate both the performance of individual food items and mixed dish items present. Several items on the records were collapsed to correspond to one food category on the FFQ. For example, cookies, cakes, doughnuts, pastries, and brownies were categorized as a single line item.

Some items on the food frequency questionnaire were excluded from the validation analysis as they were not present on diet records (126 out of 191 food items on both). An additional 19 food items were removed when < 5% of the subjects listed them on their records. This resulted in a final FFQ with 107 foods grouped into nine food categories for the validation analysis presented in this paper.

Statistical Analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS 11.5, Chicago, IL, 2003). Frequencies, medians, and means were computed for descriptive purposes. Data was examined for outliers and normality. Non-parametric tests were used since food group data were not normally distributed. Although transformation of the data improved the normality of some of the food categories, several were still positively skewed (long tail to the right). Thus, only

Spearman correlations are presented and these cannot be energy-adjusted or de-attenuated (Willett, personal communication 2003). In addition, the questionnaire is to be used in public health settings where absolute food intake is more valuable than energy-adjusted intakes. For reliability, Wilcoxen signed-ranks tests were used to compare servings per day of food groups on time 1 versus time 2, and Spearman correlations were calculated to assess test-retest reliability. For validation, Wilcoxen signed-ranks tests examined differences in food group servings between the food frequency questionnaire and diet records, and Spearman correlations determined the relative validity. Cross-classification of food group servings into same, same or adjacent, or opposite quartiles and the degree of association between FFQ and diet records was measured with contingency tables. To determine if there were statistical differences in the percentages of ethnicity between the reliability and validity studies, Proc Catmod in SAS 9.0 (SAS Institute Inc., Cary, NC, 2004) was used to perform a weighted least squares analysis of variance to achieve a Chi-Square statistic.

RESULTS

Subjects

Children in both the reliability (n = 25) and validity (n = 52) studies were 1-3 years of age (x = 2.0 ± 0.90), with approximately equal representation for both sexes. In the reliability and validity studies, the majority of children were Hispanic (60% and 57.7%), with only slightly more Caucasians (20%) than African Americans (16%) in the reliability study and African Americans (21.2%) than Caucasians (11.5%) in the validity study. Four percent and 9.6% of children in the reliability and validity studies were of mixed ethnicity, respectively. There were no statistically significant differences in the percentages of ethnic groups between the two studies ($p = 0.59$). Fifteen percent of 1-year old children in the study were classified as overweight (weight-for-length >95th percentile), and 20% of 2-3 year olds were overweight or at risk (BMI-for-age ≥ 85th percentile) (Kuczmarski et al. 2002).

In mothers, the mean age was 27 years. In the reliability and validity studies, 60% and 65.4% were Hispanic, 24% and 11.5% Caucasian, 16% and 21.2% African American, and 0% and 1.9% mixed ethnicity, respectively. The ethnicity of the mother and child did not always correspond because some were of mixed ethnicity. In the reliability study 48% were healthy weight (BMI 20-24.9 kg/m2) and 52%, overweight or obese (BMI ≥ 25 kg/m2). In the validity study all mothers were overweight or obese. The participants in both the reliability and validity studies were derived from a convenience sample of low-income mothers. A tri-ethnic sample, with a predominance of Hispanics, was used because it matches the ethnic breakdown of the population in WIC and public health clinics where it is intended for use.

Most of the participants had combined family incomes < \$15,000 per year (45%) and had completed some college (36%). About half (52%) of the mothers were working (30% full-time, 22% part-time). The mean number of children per household was two. Although none of the mothers were currently breastfeeding, only 15% had breastfed their child as an infant; the majority had formula fed (47%) or combined breast and formula feeding (38%).

Diet records for the child were available only from overweight/obese mothers who were later enrolled in an intervention; thus, only these mothers were included in the validation. However, the weight status of the subjects in these studies did not appear to influence the results, as only slight differences were observed in consumption of child food groups (starchy vegetables and soups). Nonetheless, this FFQ reflects the list of foods eaten by children, regardless of mother's weight status, and suits the purpose intended.

Test-Retest Reliability of the Food Frequency Questionnaire

Serving sizes, median servings per day from time 1 and time 2 food frequency questionnaires, and test-retest reliability correlations are shown in Table 2.1. Only sweetened beverage servings per day were significantly different between times 1 and 2. Spearman correlations were significant for all nine food categories (x = 0.69), ranging from 0.53 for soup to 0.84 for non-starchy vegetables.

Concurrent Validity of the Food Frequency Questionnaire

Table 2.2 displays median servings per day and validity correlations between food categories on the diet records and the FFQ. Servings from the food frequency questionnaire were comparable to diet records for dairy, fruits, soup, and vegetables. Spearman correlations between the questionnaire and the diet records were significant for

Table 2.1. Test-retest reliability between time 1 and 2 food frequency questionnaire (FFQ) administrations[a]

Food category	**Medium serving size**[b]	**Servings per day**		**r**[c]
		FFQ 1 median (IQR)[d]	**FFQ 2 median (IQR)**	
Breads, cereals, rice, pastas	½ slice; ½ tortilla; ½ c cereal; ¼ c rice; ½ c pasta	1.8 (1.0-3.2)	1.4 (1.0-2.9)	0.58**
Dairy	4 fl oz milk; 1 oz cheese	1.8 (1.1-3.6)	2.9 (1.5-4.2)	0.63**
Fats, oils, sweets[e]	1 tsp fat/oil; ½ small candy bar; 1- 2” cookie; ½ piece cake; ¼ c ice cream; ½ c potato chips	1.6 (0.6-3.5)	1.6 (0.7-2.6)	0.79***
Fruits, fruit juices	¼ c fruit; 3 fl oz juice ½ small fruit	1.8 (0.9-2.8)	1.6 (0.6-3.0)	0.67***
Meats, poultry, fish, beans, mixed dishes	1 oz protein equivalent	2.1 (1.2-2.9)	2.0 (1.1-3.0)	0.71***
Soup	½ c	0.07 (0.00-0.20)	0.10 (0.00-0.23)	0.53**
Sweetened beverages	3 fl oz	0.07 (0.00-0.43)	0.20 (0.03-0.61)[t]	0.74***
Vegetables, not starchy	¼ c	0.62 (0.18-1.3)	0.49 (0.19-1.5)	0.84***
Vegetables, starchy[f]	¼ c; ½ small potato	0.38 (0.18-1.06)	0.27 (0.17-0.80)	0.74***

[a]N = 25.
[b]Serving sizes from Trahms and Pipes (1997).
[c]Spearman correlations between time 1 and time 2 FFQs.
[d]IQR = interquartile range (25th-75th percentiles).
[e]Includes added fats and sugars; condiments; high-fat snacks; and sweets.
[f]Includes potatoes, corn, and peas.
[t]*P<0.05* for significant differences at time 2 as compared to time 1 FFQ.
***P<0.01*, ****P<0.001* for significant correlations.

Table 2.2. Determination of validity using comparison of food categories between diet records and the food frequency questionnaire

Food category	Diet records median (IQR)[b]	Food frequency questionnaire median (IQR)	Food frequency questionnaire % of diet records	r[a]
	← servings per day →			
Breads, cereals, rice, pastas	3.1 (2.5-5.5)	2.1 (1.2-3.1)†††	67	0.40**
Dairy	3.0 (1.7-4.1)	2.4 (1.1-3.6)	80	0.51***
Fats, oils, sweets[c]	2.5 (1.0-4.4)	1.9 (0.9-2.9)†	76	0.33*
Fruits, fruit juices	2.0 (1.1-4.3)	2.2 (1.3-3.8)	110	0.40**
Meats, poultry, fish, beans, mixed dishes	4.1 (3.1-5.6)	2.3 (1.6-4.0)†††	56	0.33*
Soup	0.00 (0.00-0.59)	0.09 (0.00-0.27)	100	0.36**
Sweetened beverages	1.3 (0.06-2.6)	0.82 (0.22-1.4)†	63	0.69***
Vegetables, not starchy	0.35 (0.00-1.1)	0.39 (0.13-1.1)	11	0.57***
Vegetables, starchy[d]	0.54 (0.01-1.3)	0.55 (0.29-0.98)	102	0.10

[a]Spearman correlations between diet records and FFQ.
[b]IQR = interquartile range (25th-75th percentiles).
[c]Includes added fats and sugars; condiments; high-fat snacks; and sweets.
[d]Includes potatoes, corn, and peas.
†*P<0.05*, †††*P<0.001* for significant differences between diet records and FFQ.
**P<0.05*, ***P<0.01*, ****P<0.001* for significant correlations.

all food groups (x = 0.41) except for starchy vegetables. Correlations were not significantly different by ethnicity.

Cross-classification into quartiles of food group servings per day for the food frequency questionnaire and diet records is illustrated in Table 2.3. On average, 36% of children were classified in the exact same quartile and 78% in the same or within one quartile of intake for both dietary assessment methods. Gross misclassification, or classification into opposite/extreme quartiles by the two methods, ranged from 0% for dairy, sweetened beverages (not juices), and vegetables (not starchy) to 8% for starchy vegetables.

Table 2.3. Proportion of children classified in the same, within one, or in opposite quartiles for servings per day of food categories by the food frequency questionnaire and the diet records

Food category	Same quartiles	Same or within one quartile	Opposite quartiles
	←	%	→
Breads, cereals, rice, pastas	42	81	6
Dairy	40	79	0
Fats, oils, sweets[a]	37	77	6
Fruits, fruit juices	37	71	4
Meats, poultry, fish, beans, mixed dishes	27	71	6
Soup	33	83	4
Sweetened beverages	42	94	0
Vegetables, not starchy	39	79	0
Vegetables, starchy[b]	31	71	8

[a]Includes added fats and sugars; condiments; high-fat snacks; and sweets.
[b]Includes potatoes, corn, and peas.

DISCUSSION

The 191-item food frequency questionnaire tested in a tri-ethnic sample of low-income, 1-3 year old children yielded excellent reliability and acceptable validity. This suggests that our food frequency questionnaire is useful for identifying food choices in young Hispanic, African American, and Caucasian children of this age group.

In test-retest reliability studies using FFQs, correlations between foods/food groups at time 1 and 2 ranged from 0.29 to 0.75. In our study, test-retest correlations ranged from 0.5 to 0.9 (x = 0.69), and were similar to, or higher than, mean test-retest correlations reported by others, which include: 0.29 (Nomura et al. 1976), 0.35 (Thompson et al. 1987), 0.41 (Byers et al. 1987), 0.55 (Colditz et al. 1987), 0.57 (Ajani et al. 1994, Salvini et al. 1989), 0.59 (Feskanich et al. 1993), 0.62 (van Liere et al. 1997), 0.64 (Elmstahl et al. 1996), 0.66 (Erkkola et al. 2001), 0.67 (Bohlscheid-Thomas et al. 1997), 0.68 (Pisani et al. 1997), 0.69 (Mannisto et al. 1996), 0.70 (Flagg et al. 2000, Smith-Warner et al. 1997), and 0.75 (Ocke et al. 1997). Thus, our questionnaire demonstrates good reliability in the population of young children tested.

The higher values seen in this study may be due to the shorter time span between time 1 and 2 (3-4 weeks) compared to others (1-10 years), as test-retest correlations diminish with time between tests (Goldbohm et al. 1995, Tsubono et al. 1995). However, long time intervals may be inappropriate for habits that change rapidly (food intake in children), as changes in food choices may be mistaken for poor performance on the questionnaire over time (Frank-Stromborg and Olsen 1997).

Servings per day from the second FFQ were not significantly different from the first, with the exception of sweetened beverages (2.9 X greater at time 2). Although this increase appears large, it is due solely to two children who increased their servings/day from 0.6 to 2.5 and 0.3 to 1.1. Thus, with the exception of sweetened beverages, our repeat questionnaire did not show significant underestimation (Domel et al. 1994, Rockett et al. 1995, Warneke et al. 2001) or overestimation (Erkkola et al. 2001, Flagg et al. 2001) compared to the first testing as found by other studies of foods/food groups in older children and adults.

The mean percentage of subjects correctly classified into the same quartile or into the same or within one quartile by both the questionnaire and diet records was 36% and 78%, respectively. Although categorization into quartiles of food group intake has not been done in FFQ validation studies for 1-3 year olds, this method is commonly used to provide support for validity of FFQs in adults (Bohlscheid-Thomas et al. 1997, Bonifacj et al. 1997, Erkkola et al. 2001, Mannisto et al. 1996, Torheim et al. 2001, van Liere et al. 1997). Furthermore, our results are similar to values for adult questionnaires involving placement into the same quartiles: 35% for seven food groups (Torheim et al. 2001) and 36.6% for 15 foods (Bonifacj et al. 1997); or into the same or adjacent quartiles, 76% for 13 foods (van Liere et al. 1997). The percentage of subjects grossly misclassified ranged from 0% - 8%, but some degree of misclassification by this dietary method is inevitable. Others have reported similar ranges for gross misclassification for foods or food groups, including 0% to 23% (Erkkola et al. 2001), 0% to 4.8% (Bohlscheid-Thomas et al. 1997), 3% to 20% (Mannisto et al. 1996), and 5% to 9% (Torheim et al. 2001).

Validity correlations commonly range from 0.4 to 0.7 for nutrients, but may be more variable with foods/food groups as daily fluctuations in food intake are typically greater than changes in nutrients (Nelson 1997). Of all the food items on the FFQ, beverages had the strongest associations with diet records, presumably due to the increased frequency of beverage consumption (i.e. milk, fruit juices, fruit drinks, and sodas) of young children. Our correlations of 0.44, 0.67, 0.67, 0.69, and 0.78 for orange juice, apple juice, sweetened beverages (i.e. sodas, ades, sweetened teas), 2% milk, and whole milk (data not shown), respectively, are similar to those of Marshall et al. (2003) in 6 month to 5 year old children for liquid soft drinks (0.47), powdered soft drinks (0.57), juice (0.63), and cow's milk (0.77). Others also have reported higher correlations for beverages as compared to most other foods (Forman et al. 1999, Salvini et al. 1989, Torheim et al. 2001).

The average validity correlation in this study (0.41) of children was comparable to, or lower than, those reported in adults (0.4-0.7), presumably due to the greater variability of food intake of children (Nelson et al. 1989) and the attenuation (decrease in correlations) from within-person, day-to-day variability in diet records (Willett 1998). In validity studies with foods/food groups, mean crude correlations between the FFQ(s) and diet recalls/records ranged from 0.20 to 0.82, including: 0.12, 0.17, and 0.19 (Forman et al. 1999); 0.20 (Sauvaget et al. 2002); 0.28 (Jensen et al. 1984); 0.34 and 0.37 (Warneke et al. 2001); 0.35 and 0.42 (Feskanich et al. 1993); 0.36 (Torheim et al. 2001); 0.43 (Bonifacj et al. 1997, van Assema et al. 2002); 0.44 (Pisani et al. 1997, Smith-Warner et al. 1997), 0.45 (Bohlscheid-Thomas et al. 1997, van Liere et al. 1997); 0.47 (Erkkola et al. 2001); 0.48 (Salvini et al. 1989); 0.53 (Mannisto et al. 1996); 0.55 (Ocke et al. 1997); 0.56 (Flagg et al. 2000); 0.65 (Horwath and Worsley 1990); 0.73 (Hankin et al. 1975); and 0.82 (Abramson et al. 1994).

Compared to diet records, the food frequency questionnaire underestimated intake for four out of nine food groups and had no significant overestimates. The only other study conducted in young children that examined validity using food groups reported both slight over- and under-estimation by the FFQ as compared to diet records (Marshall et al. 2003). In adults, the FFQs generally overestimate foods or food groups as compared to diet records (Erkkola et al. 2001, Salvini et al. 1989, Torheim et al. 2001, van Assema et al. 2002). The exception is a study by Forman et al. (Forman et al. 1999) who reported an underestimation of food intake.

A plausible reason for the discrepancy between food group servings from the two instruments in our study may be that the mothers had difficulty reporting accurate serving sizes on the FFQ. Although training was given by dietitians on portion sizes to improve the reporting, mothers appeared to indicate larger portion sizes for some foods on the diet records than they marked on the FFQ. Other studies have cited subject's difficulties with portion size estimation as a cause for lower validity correlations between the diet records and the questionnaire (Haraldsdottir et al. 1994, Salvini et al. 1989).

A limitation of this study is the use of only three days of diet records for validation. However, a longer time period and greater number of diet records was not feasible due to the limited education, resources, and incentive of the subjects. There were slight differences in the representation of ethnic groups between the reliability and validity studies because subjects were recruited from a convenience sample, but the food choices of the three ethnicities did not differ significantly. Thus it appears that the food choices are more a function of socioeconomic status, rather than ethnicity. Regardless, this FFQ is culturally appropriate as it was designed to include foods consumed by Hispanic, African American, and Caucasian children. In addition, although the generalizability of this questionnaire may be limited to overweight/obese mothers, 62% of the low-income population intended for its use are overweight/obese. Although no children were still breastfeeding, 14% of mothers offered their 1-3 year old child formula at least once per day. Thus, an addendum was added later that included types of formula and breast milk with nine new response options that ranged from "never or < once per month" to "7 + per day" for milks and formulas. In addition, seven new food items present on the diet records but not on the FFQ were added to better reflect the food choices of these children (American cheese slices; ground beef, not as a mixed dish; grilled/broiled fish; apricots; toddler cereal bars; toddler wagon wheels; and soy milk).

CONCLUSIONS

This food frequency questionnaire can identify food choices in children, ages 1-3 years old. Early detection of poor dietary habits in children may reduce the development of overweight.

The inadequate consumption of whole grains, vegetables, and calcium-rich foods in these low-income children suggests that dietetics professionals must continue to emphasize the importance of these foods.

Chapter 3: Low-Income, Overweight/Obese Mothers Act as Agents of Change to Improve Food Choices and Fat Habits in Their 1-3 Year Old Children

ABSTRACT

Objective: To examine the effects of a weight loss program for mothers on the diet and activity of their 1-3 year old children.

Design: A convenience sample of low-income mothers participated in an 8-week intervention emphasizing healthful eating, physical activity, and lifestyle changes for the family.

Subjects/Setting: Participants (n=91) were recruited from the Special Supplemental Program for Women Infants and Children (WIC) and public health clinics. Subjects were overweight/obese, tri-ethnic low-income mothers of children 1 – 3 years old.

Statistical Analyses Performed: Analysis of variance determined differences in continuous variables by categorical variables. Paired-sample t-tests measured significant pre-post changes for continuous variables. Spearman correlations examined relationships between mother and child diet. Nutrient data was adjusted for within-person, day-to-day variation.

Results: This educational program improved the diet and activity behaviors of both mothers and children. Initial energy intakes of children exceeded Estimated Energy Requirements and were reduced to acceptable levels following the intervention. Beneficial changes in mothers and children were decreased total/saturated fat, high-fat snacks/desserts, added fats, sweetened beverages, and fast food consumption, and increased home-prepared meals. Physical activity improved in mothers and children.

Conclusions: The offer of a free weight loss class was a successful method of enticing low-income women to participate in an educational intervention that benefited their children. We found that overweight/obese mothers who modified their food choices and fat habits made comparable changes for their child, and the most frequently offered foods appeared no different from those provided in higher income families.

INTRODUCTION

Pediatric obesity is paralleling the epidemic of obesity in adults. Of particular concern is the prevalence of overweight among infants (11%) and overweight/at risk in 2-5 year olds (22%) (Hedley et al. 2004, Ogden et al. 2002). The main concern over child obesity is its associated co-morbidities, including hypertension, insulin resistance, and type 2 diabetes (Berenson et al. 1998, Mahoney and Burns 1996), as well as adverse social consequences (Freidlander et al. 2003, Morgan et al. 2002).

Interventions should be initiated early in life, as food habits are formed at a young age (Birch et al. 1998) and excess weight becomes more difficult to treat as one becomes older (Dietz 1999). Mothers should be the focus of interventions for childhood obesity, as they are the primary providers of food. Also, maternal body mass index (BMI) is a significant predictor of pediatric BMI in low-income, preschool children (Gyovai et al. 2003, Melgar-Quinonez and Kaiser 2004, Whitaker 2004). Thus, interventions in families with overweight/obese mothers are critical for preventing obesity in the child.

One limitation in empowering parents to initiate behavioral changes for their offspring is that most parents of overweight children do not acknowledge that a problem exists (Young-Hyman et al. 2000). Additional challenges faced when working with low-income mothers include misconceptions (i.e. a bigger baby is better, my mother is the best source of nutrition information) and inappropriate feeding strategies (i.e. use of food to control child's behavior) (Baughcum et al. 1998).

Only two studies were conducted that involved *weight loss* in parents for the *prevention* of obesity in children (Epstein et al. 2001; Harvey-Berino and Rourke 2003). Other interventions have targeted parents for weight loss and role modeling, in combination with obesity *treatments* in older children (Epstein et al. 1981, Epstein et al.

1984, Kirschenbaum et al. 1984, Raynor et al. 2002). Others have developed programs for children that did not encourage weight loss in the mother. These include obesity prevention for 3-4 month olds (Pisacano et al. 1978), cardiovascular disease risk reduction for 7-36 month olds (Simell et al. 2000), obesity treatment for 3-6 year olds (Ray et al. 1994), and fruit and vegetable promotion for 1-5 year olds (Cox et al. 1996, Del Tredici et al. 1988, Havas et al. 1998, Koblinsky et al. 1992).

We believe that one effective strategy for obesity prevention in very young children use low-income, overweight/obese mothers as agents of change. The purpose of this study is to examine the influence of an educational weight loss program in mothers on the diet and activity of their 1-3 year olds.

METHODS

Design of Study

Low-income, tri-ethnic mothers (n=91) participated in an 8-week weight loss intervention. Subjects were measured for height, weight, waist circumference, body fat (mother only), and head circumference (child only) at weeks 0, 8, and 24. Mothers completed demographic and dietary questionnaires for themselves and their child [24-hour recalls, 2-day diet records, and food frequency questionnaires (FFQs)] at weeks 0 and 8. Activity was assessed in children via a Toddler Behavior Assessment Questionnaire (TBQ) and in mothers with pedometers worn for 3-day intervals at weeks 0 and 8.

Determination of Weight Status

Height and weight (kg/m^2) were used to calculate BMI in mothers and children ≥ 2 years. In children ≥ 2 years old, BMI-for-age percentile levels were determined using Centers for Disease Control and Prevention (CDC) growth charts (Kuczmarkski et al. 2002). Weight classifications included: underweight, < 5^{th} percentile; normal weight, ≥ 5^{th} and < 85^{th}; at risk for overweight, ≥ 85^{th}; and overweight/obesity, ≥ 95^{th}. In children < 2 years old, weight-for-length was used, and children < 5^{th} percentile were classified as underweight; 5^{th} - 95^{th}, as normal weight; and > 95^{th}, as overweight.

Subjects

Mother-child pairs were recruited from WIC and public health clinics. Eligibility was a 1-3 year old child, a combined family income < 200% of federal poverty level, ≥ 18 years old, literate in English, and not breastfeeding significantly (<5 minutes/day). Subjects were informed of the benefits and risks of the study and informed consent was obtained. The Institutional Review Board of The University of Texas at Austin approved the study.

The retention rate for completion of the 6-month intervention was 48%. An additional 33 subjects were excluded from the final analyses because they had a child < 1-year or ≥ 4 years old (n=18), were breastfeeding (n=10), or did not return all questionnaires (n=5). Thus, the final sample size was 91. Factors influencing attrition in this program included lack of transportation, time, childcare, and family support; illness or death; work and family responsibilities; holidays; and stress. Drop-outs did not differ from intervention subjects in anthropometrics or demographics, but were more likely to be single ($p<0.05$) and to have never worked ($p<0.01$).

Demographic/Health Status

A 33-item general questionnaire contained information on age, income, education, ethnicity, parity, childbirth, and employment status. Additional questions addressed family problems, current practices to lose weight, and mother and child health histories.

Nutrient Intakes of Children

Nutrient intake was calculated using data from 24-hour recalls and 2-day diet records for children as recorded by mothers. A trained registered dietitian administered the 24-hour recall. Strategies used to improve accuracy included the use of measuring utensils and food models to help determine portion sizes and detailed instructions for appropriate completion of an additional 2 days of food records (one week day and one weekend day). The diet records were reviewed and clarified with the subject to ensure completeness. Data from the recall and records were analyzed using Food Processor 7.71 (ESHA Research, Version 7.81, 2001).

Nutrients were adjusted using Software for Intake Distribution Estimation (SIDE, version 1.0, 2002), a program that statistically enhances nutrient data to obtain better estimates of long-term, usual intake. Nutrient data does not include that from supplements.

Estimated Energy Requirements (EERs) for children were based on equations that allowed for energy balance, plus a factor for growth (Institute of Medicine 2002). All children had plausible energy intakes (500 - 3000 kcals). The proportion above/below the Acceptable Macronutrient Distribution Ranges (AMDRs) for % energy from macronutrients was determined. For nutrients with an Estimated Average Requirement (EAR), the EAR cut-point method identified the proportion with intakes below the EAR (Institute of Medicine 2000). The Adequate Intakes (AIs) recommendations were used for nutrients without an EAR. The percentage of children above the Tolerable Upper Intake Levels (ULs) also was evaluated.

Manganese was classified as an antioxidant because of its essential role as a cofactor in the superoxide dismutase enzyme (Freeland-Graves et al. 2004). Vitamin A intakes (RE) were compared to the previous 1989 Recommended Dietary Allowances (RDAs) (Recommended Dietary Allowances 1989) as retinol activity equivalents (RAEs) from the dietary software were unavailable.

Food Choices of Mothers and Children

Food frequency questionnaires (FFQs) developed and validated for a tri-ethnic population of adults (George et al. 2004) and 1-3 year old children (Klohe et al., in press) determined servings/day of foods and food groups. Both FFQs were derived from the Health Habits and History Questionnaire (Block et al. 1992), but were modified to include ethnic foods, low-fat foods, restaurant/fast foods, and supplements. The child FFQ, completed by the mother, was further modified to include age-appropriate foods and portions. Mean coefficients were 0.73 and 0.69 for reliability, and 0.45 and 0.41 for validity, in the mother and child FFQs, respectively.

Frequency was determined via a nine-point response scale ranging from “never or < once per month” to “2 + servings per day” for food items. Subjects were asked to identify the portion size consumed based on fractions of a medium serving, with a small serving designated as ½ the medium; a large, 1 ½ times the medium; and an extra large, 2 times the medium serving. The FFQs were checked by a registered dietitian to ensure accuracy. Fractions of servings/day from the frequency responses were calculated and multiplied by the serving size (as a multiple of a medium serving). Servings/day of food items with similar nutrient profiles were summed to determine food group servings/day.

Physical Activity of Mothers

Mothers wore pedometers (Model AE170, Accusplit, San Jose, CA) for 3 days to assess physical activity. The Accusplit AE170 model is the Yamex Digiwalker SW-701 sold with a different manufacturer’s label. The Yamex Digiwalker SW-701 has been shown to be accurate (Schneider et al. 2004) and to exhibit validity as evidenced by significant correlations with steps during walking (r=0.84) and VO_2 max (r=0.75) (Hendelman et al. 2000).

Physical Activity of Children

The activity scale of the Toddler Behavior Assessment Questionnaire (TBAQ) determined activity in the children. The full questionnaire (108 items) consists of several temperament scales, one of which is the 7-item activity scale used in this study. Cronbach’s α for the activity scale was 0.71, and it has been validated in parents of toddlers (Goldsmith 1996). The definition of activity level used in the TBAQ was “limb, trunk, or locomotor movement during a variety of daily situations, including free play, confinement, or quiet activities." The 7-point response options had values ranging from 1 (never) to 7 (always observed the behavior during the last two weeks), with a "does not apply" option available. Values were summed and divided by total number of items with responses for a total score.

Description of Weight Loss Program for Mothers

Registered dietitians taught eight weekly 1 ½ hour classes that included a 15-minute weigh-in, followed by a 1 ¼ hour discussion and activities. The program promoted nutritious food choices and lifestyle changes for good health and weight loss, with components of behavioral modification and physical activity (Clarke et al., in submission).

Design for the weight loss program was grounded in basic concepts of the Social Cognitive Theory (SCT) (Figure 3.1). Its premise is that an individual's health behavior can be attributed to an interaction of his/her cognitions, behaviors, and environment, and modification of any of these components will alter the individual's behavior (Bandura 1977). Objectives of the interventions can be divided into two major categories: change in mother's cognitions and behaviors. Enhanced knowledge of general health, nutrition, and parenting skills should enable the mother to make behavior changes that affect the home environment to positively influence the child's diet and activity behaviors.

Other cognitive-behavioral strategies used included self-monitoring, stimulus control, and contingency management. Self-monitoring techniques consisted of diet records and pedometers to measure steps/calories expended in activities. Participants identified triggers and alternatives to less healthful eating (stimulus control). Prizes were given for obtaining goals and participants were encouraged to reward themselves for

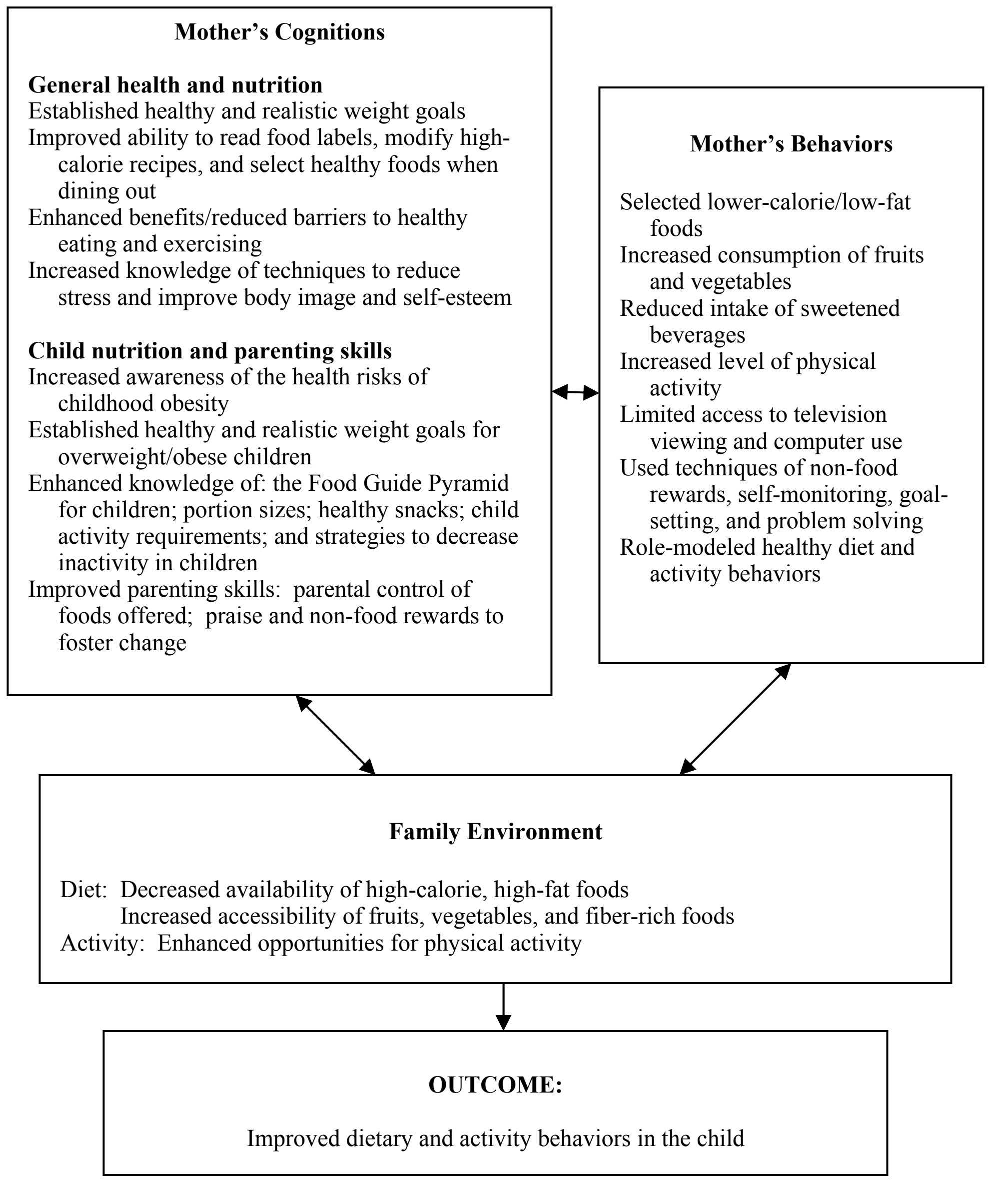

Figure 3.1. Conceptual model for the prevention of child obesity using mothers as agents of change.

achievements (contingency management). Additional techniques included goal-setting, individualized feedback, parenting and coping skills, and relapse prevention.

The dietary component utilized well-balanced eating plans, discussion of health benefits of foods and nutrients, and development of culturally-sensitive meal planning skills. Interactive components were low-fat cooking demonstrations, modification of recipes, and the sharing of strategies found to be effective for weight loss. The Food Guide Pyramid (FGP) and serving sizes for adults and children were taught with colorful handouts.

The relationship of physical activity to weight and methods to increase frequency/type were incorporated into most classes. Activities to share with their children also were discussed.

Statistical Analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS 11.5, Chicago, IL, 2003). Frequencies, medians, and means were computed for descriptive purposes, and data examined for outliers and normality. Analysis of variance determined significant differences in continuous variables by categorical variables. Paired-sample t-tests measured significant differences pre-post for continuous variables. Spearman correlations examined the relationship between mother and child change variables.

RESULTS

The 91 participants were a tri-ethnic sample (62.6% Hispanic, 22.0% African American, and 15.4% Caucasian) of obese (75.8%) and overweight (24.2%) mothers of 1-3 year olds (Table 3.1). The most frequently reported income and education levels were $15,000-$29,999 (51.6%) and partial college (35.2%), respectively. Only 17.6% breastfed their child during infancy; 29.7% fed formula and 52.7% provided a combination. According to CDC growth charts, 24% of 1-year olds were overweight, and 19.5% of 2-3 year olds were overweight (7.3%) or at risk (12.2%).

Initially, mothers had a weight of 92 kg, 43% percent body fat, and a waist circumference of 106 cm. By post-intervention, mothers lost weight (x = -2.7 kg, $p < 0.001$) and decreased body fat (-1.2 %, $p < 0.001$) and waist circumference (-3.4 cm, $p < 0.001$). The declines remained significant at follow-up. During this study, the children gained slightly in height, weight, and head circumference as expected for normal growth. At follow-up, only 2-3 year olds increased weight-for-height (57.0 to $67.9^{th\%ile}$, $p < 0.01$). Changes in waist circumference at weeks 0, 8, and 24 were not significant (50.3 cm, 50.3 cm, 51.3 cm, respectively).

Table 3.2 displays changes in macronutrient intake of children following the intervention in their mothers. At week 0, energy intakes were above the EERs. The % above the EERs dropped from week 0 to 8: 125% to 101% for 1-2 year old boys, 126% to 113% for 1-2 year old girls, 116% to 100% for 3 year old boys, and 104% to 90% for 3 year old girls, respectively ($p<0.05$ for all). Total fat intake declined; however, the reduction in saturated fat was significant only in 2-3 year olds. For other macronutrients, the majority of the sample was within the AMDRs. Fiber intake was less than the AI (~46%).

Table 3.1. Demographic and anthropometric characteristics of intervention mothers and children[a]

Characteristic	Mean ± SD[b], Mode[c], or Frequency[d]
Mothers	
Age, yrs[b]	27.1 ± 5.9
BMI, kg/m^2 [b]	34.9 ± 6.9
Income[c]	\$15,000 to \$29,999
Education level[c]	partial college
Number of children in household[b]	2.1 ± 1.2
Method of infant feeding used with child[d]	
Breast milk	16.0
Formula	27.0
Combination breast milk & formula	48.0
Children	
Age[b]	2.1 ± 0.9
Sex[d]	
Boys	45.0
Girls	46.0
Overweight[d]	
1-year olds[e]	12.0
Overweight or at risk for overweight[d]	
2-3 year olds[f]	8.0

[a]N = 91
[b]Mean ± standard deviation (SD)
[c]Mode
[d]Frequency
[e]Weight-for-length > 95^{th} percentile
[f]BMI-for-age ≥ 85^{th} percentile

Table 3.2. Macronutrient intake of children pre- and post-weight loss intervention in mothers as determined by 24-hour recall and 2-day diets

Nutrient	EAR or AI (AMDR)[b]	Macronutrient intake[a] 1 year olds[c] Week 0	1 year olds[c] Week 8	2-3 year olds[d] Week 0	2-3 year olds[d] Week 8	%<EAR or AMDR	%>AMDR
Energy, kcals	917-1015; 1306-1398[e]	1151-1271[f]	1028-1038[f] ***	1354-1620[g]	1181-1400[g] *	NA[h]	NA
Carbohydrate, g	**100**	141	126*	200	163***	11.0	NA
(% EN[i])	(45-65)	(51)	(51)	(55)	(54)	13.2[j]	4.4
Protein, g	**11**[k]	43	41	51	49	0	NA
(% EN)	(5-20)	(15)	(17*)	(14)	(16***)	0[j]	6.6
Fat, g	ND[l]	43	38*	53	43**	NA	NA
(% EN)	(30-40)	(35)	(34)	(32)	(31)	27.5[j]	12.1
Saturated fat, g	ND	19	16	20	17*	NA	NA
Cholesterol, mg	ND	175	179	186	186	NA	NA
Fiber, g	19*	7	8	10	10	NA	NA

[a]Mean intake
[b]Estimated Average Requirements (EARs) in **bold type**; Adequate Intakes (AIs) in ordinary type followed by an asterisk (*); Acceptable Macronutrient Distribution Ranges (AMDRs) in parentheses for carbohydrate, protein, fat, and sugar
[c]N = 50
[d]N = 41
[e]Estimated energy requirement (EER) for 1-2 year olds = 917 kcals (girls) and 1015 kcals (boys); 3 year olds = 1306 kcals (girls) and 1398 kcals (boys)
[f]Mean energy intake for 1-2 year old girls and boys
[g]Mean energy intake for 3 year old girls and boys
[h] NA = not applicable
[i]%EN = percent of total energy intake
[j]Percent with intakes below the AMDR
[k]0.88 g/kg, based on mean weight of 12.8 kg
[l]ND = not determined
****P<0.001, **P<0.01, *P<0.05* for significant differences from week 0

Pre- and post-intervention values for micronutrients are shown in Table 3.3. The percentage of children below the EARs at baseline was considerable for vitamins A (29.7%) and E (74.7%) and folate (22%). Vitamin D was less than the AI (~95%), and calcium was above (~151%), at both pre- and post-intervention. The proportion of children exceeding the UL's was low, except for niacin (47.3%) and zinc (27.5%). Nutrient data of the mothers are presented in a companion article (Clarke et al., in submission).

Table 3.4 displays food group servings/day from the FFQs. Following the weight loss intervention in mothers, intakes of breads, fruits and fruit juices, meats, snacks/desserts, and sweetened beverages declined in children. Vegetable and grain consumption were below Food Guide Pyramid recommendations (~58% and 45%, respectively). Although there was a significant decrease in vegetables post-intervention, this decline was negated when fried potatoes were excluded from analysis. Children were eating at least two servings of snacks/desserts/condiments, and almost one serving of sweetened beverages/day, at pre-intervention. These decreased ~50% post-intervention. Consumption of high fat snacks/desserts and sweetened beverages was related positively to energy ($p<0.01$), fat ($p<0.01$), saturated fat ($p<0.05$), and sodium ($p<0.001$), even after controlling for age.

Pre-post changes in food group servings of children were related to similar modifications in the mother's diet, with the exception of low-fat dairy, fruit juices, and high-fat snacks/desserts (Table 3.4). Thus, mothers that increased their fruits and vegetables, or decreased sweetened beverages, reported similar trends in their children.

It is not surprising that the foods frequently consumed by mothers also were prepared in their children's diets (Table 3.5). At post-intervention, mothers and children

Table 3.3. Micronutrient intake of children pre- and post-weight loss intervention in mothers as determined by 24-hour recall and 2-day diets

			Vitamin and mineral intake[a]					
	EAR or AI[b]	UL[c]	1 year olds[d]		2-3 year olds[e]		% <EAR week 0	% >UL week 0
Nutrient			**Week 0**	**Week 8**	**Week 0**	**Week 8**		
Antioxidants								
Vitamin C, mg/d	**13**	400	72	42**	86	56**	2.2	2.2
Vitamin E, mg/d	**5**	200	3.8	3.3	4.2	3.7	74.7	0
Selenium, µg/d	**17**	90	36	36	38	42	8.8	0
Manganese, mg/d	1.2*	2	1.1	0.8***	1.4	1.2	NA	12.1
B vitamins								
Thiamin, mg/d	**0.4**	ND[f]	0.9	0.8**	1.0	0.9	3.3	NA[g]
Riboflavin, mg/d	**0.4**	ND	1.4	1.3	1.5	1.4	0	NA
Niacin, mg/d	**5**	10	9.5	8.7	11	11	6.6	47.3
Vitamin B_6, mg/d	**0.4**	30	1.0	0.9	1.0	1.0	1.1	0
Folate, µg/d	**120**	300	166	159	194	192	22.0	5.5
Vitamin B_{12}, µg/d	**0.7**	ND	2.6	2.4	2.5	2.6	2.2	NA
Bone-related nutrients								
Calcium, mg/d	500*	2500	805	702*	790	726	NA	0
Phosphorus, mg/d	**380**	3000	786	737	844	802	4.4	0
Magnesium, mg/d	**65**	65[h]	140	134	152	151	3.3	…[h]
Vitamin D, µg/d	5*	50	4.9	4.7	4.8	4.5	NA	0
Other micronutrients								
Vitamin A, µg/d RE	400[i]	NA	572	596	561	689	29.7	NA
Vitamin K, µg/d	30*	ND	28	28	27	40*	NA	NA
Iron, mg/d	**3**	40	10	7.7**	10	9.0	4.4	0
Zinc, mg/d	**2.5**	7	6.1	5.4*	5.9	6.0	2.2	27.5
Sodium, mg/d	ND	ND	1545	1435	2237	1825***	NA	NA
Copper, µg/d	**260**	1000	481	425	540	521	7.7	0

[a]Mean intake
[b]Estimated Average Requirements (EARs) in bold type; Adequate Intakes (AIs) in ordinary type followed by an asterisk (*)
[c]UL = tolerable upper intake level
[d]N = 50
[e]N = 41
[f]ND = not determined
[g]NA = not applicable
[h]Applies to intake from supplements and medications only, not food and water
[i]Based on 1989 RDA for vitamin A in retinol equivalents (RE)
***$P<0.001$, **$P<0.01$, *$P<0.05$ for significant differences from week 0

Table 3.4. Servings per day of food groups pre- and post-intervention and correlations as determined by the food frequency questionnaire[a]

Food category	Mean servings of food groups per day: Week 0[b] Mother	Week 0[b] Child	Week 8 Mother	Week 8 Child	Mother-child correlation[c]
Bread, cereal, rice, and pasta	3.4 ± 2.5	3.1 ± 2.3	1.6 ± 1.1***	2.3 ± 1.9***	0.33**
Dairy	1.9 ± 1.6	2.9 ± 2.0	1.2 ± 0.9***	2.6 ± 1.7	0.27*
Regular dairy	1.6 ± 1.8	2.7 ± 2.1	0.7 ± 0.8***	2.3 ± 1.8	0.40***
Low fat dairy	0.2 ± 0.4	0.3 ± 0.6	0.4 ± 0.5*	0.3 ± 0.7	0.01
Fruits and fruit juices	2.6 ± 1.9	3.2 ± 2.4	2.3 ± 1.8	2.3 ± 1.9***	0.17
Fruits	1.8 ± 1.5	2.1 ± 1.7	1.9 ± 1.7	1.6 ± 1.5*	0.34**
Fruit juices	0.8 ± 0.8	1.0 ± 0.8	0.3 ± 0.4***	0.6 ± 0.6***	0.05
Meat, poultry, fish, beans, eggs	3.5 ± 2.9	2.6 ± 2.1	2.2 ± 1.4***	2.1 ± 1.8*	0.34**
Snacks, desserts, condiments, spreads: High fat	2.5 ± 2.2	1.6 ± 1.6	0.6 ± 0.6***	0.9 ± 0.8***	0.16
Snacks, desserts, condiments, spreads: Low fat	0.4 ± 0.4	0.9 ± 1.0	0.4 ± 0.4	0.7 ± 0.9*	0.28**
Sweetened beverages[d]	1.6 ± 1.5	0.8 ± 0.9	0.7 ± 1.0***	0.4 ± 0.5***	0.42***
Vegetables	3.6 ± 2.8	1.9 ± 1.5	3.3 ± 2.4	1.6 ± 1.2*	0.43***
Vegetables, excluding fried potatoes	3.3 ± 2.8	1.7 ± 1.4	3.2 ± 2.5	1.5 ± 1.2	0.43***

[a]N = 91.
[b]Mother serving sizes based on the Food Guide Pyramid. Child serving sizes based on Trahams & Pipes (1997).
[c]Spearman correlation between change in mother's food group servings and change in child's food group servings.
[d]Includes fruit drinks, sodas, and sweetened teas.
$^{*}P<.05$, $^{**}P<.01$, $^{***}P<.001$ for significant differences from week 0 and for significant correlations.

Table 3.5. Most frequently consumed foods (percent eating weekly) by mothers and children[a]

Food Category	Mother	Food Category	Child
Bread, cereal, rice, pasta			
Flour tortillas	57.1	Pretzels, crackers	61.5
Whole wheat bread	57.1	Unsweetened cereal	58.2
White bread	52.7	White bread	54.4
Dairy			
Cheddar, American, Swiss cheese	52.7	Whole milk	78.0
Whole milk	47.3	Cheddar, American, Swiss cheese	58.2
Mixed dishes with cheese	33.0	Mixed dishes with cheese	45.1
Fats and added sugars			
Margarine	53.9	Nuts, peanut butter	48.4
Salad dressing, mayonnaise	53.8	Margarine	40.7
Butter	51.6	Butter	35.2
Fruits and fruit juices			
Bananas	59.3	Bananas	74.4
Orange juice	55.6	Apple juice	67.0
Apples, applesauce, pears	42.2	Apples, applesauce, pears	65.6
Meat, fish, poultry, mixed dishes with meat			
Hamburgers, cheeseburgers	56.0	Eggs	58.2
Cold cuts, lunch meats	55.6	Chicken nuggets, fried chicken	49.4
Eggs	52.8	Hamburgers, cheeseburgers	48.4
Snacks, sweets			
Potato/tortilla chips, popcorn	54.4	Animal/graham crackers	59.3
Chocolate candy	47.3	Potato/tortilla chips, popcorn	51.6
Cookies, cake	42.9	Cookies, cake	41.8
Sweetened beverages			
Regular soft drinks, colas	68.5	Fruit drinks: Hi-C®, Kool-Aid®	54.9
Tea	53.9	Regular soft drinks, colas	44.0
Fruit drinks: Hi-C®, Kool- Aid®	47.2	Other drinks: Gatorade®, Snapple®	29.7
Vegetables			
Tomatoes	67.4	French fries, fried potatoes	69.2
Onions	64.8	Corn	63.7
French fries, fried potatoes	63.3	Boiled, baked, mashed potatoes	57.1

[a] N = 91. Data obtained from food frequency questionnaires.

decreased intakes of refried beans, fried potatoes, bacon, chicken nuggets, hamburgers, enchiladas, peanut butter, biscuits, soft cheeses, regular salad dressing, butter/margarine, cookies/cakes, added sugars, fruit drinks, and sodas (Figure 3.2). In contrast, mothers increased servings of lettuce salads, carrots, and low-fat yogurt, but these changes were not significant in the child. Both mothers and children consumed more roasted/broiled chicken and water following the program.

At post-intervention, mothers used cooking spray, or low-fat/monounsaturated fats in cooking, and less other fats (Table 3.6). Mothers and children also were less likely to eat from fast food restaurants and to consume skin on chicken. Fast foods were related positively to energy ($r=0.21$, $p<0.05$) and sodium ($r=0.24$, $p<0.05$), and inversely to calcium ($r=-0.24$, $p<0.05$) and vitamin D ($r=-0.33$, $p<0.01$); fast foods were not associated with and child weight ($r=-0.12$, $p=0.254$).

The activity level of both mothers and children increased by post-intervention, but it was not related within mother-child pairs (Table 3.7). By week 8, boys were more active than girls, and 1-year-olds and overweight/at risk children enhanced their activity level significantly.

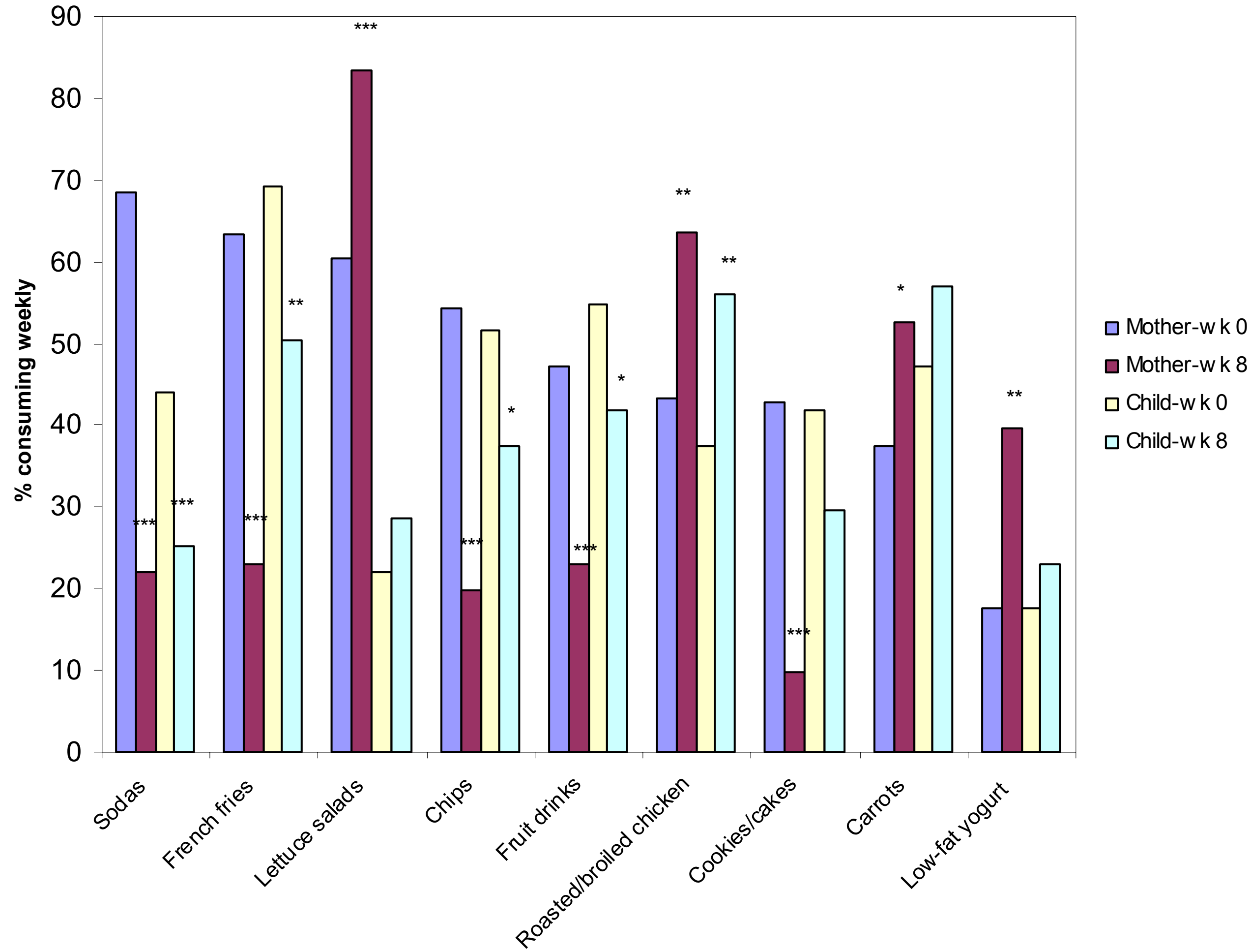

Figure 3.2. Pre (week 0)- post (week 8) changes in mother-child consumption of select food items.

Table 3.6. Fat habits and restaurant food consumption in mothers and children[a]

Fat use and fat habits	Consumption, %			
	Week 0		Week 8	
	Mother	Child	Mother	Child
Fats added/used for cooking				
No fats or cooking spray	22.7	19.7	66.7***	68.2***
Low-fat/monounsaturated fats[b]	36.9	28.8	69.7**	63.6**
Other fats[c]	81.8	81.8	39.4***	40.9***
Fats added to vegetables				
No fats or cooking spray	10.6	12.1	47.0***	40.9***
Low-fat/monounsaturated fats[b]	24.2	21.2	47.0**	45.5**
Other fats[c]	81.8	78.8	39.4***	45.5***
Fat habits				
Seldom eats the skin on chicken	42.4	65.2	90.9***	83.3**
Seldom eats the fat on meat	57.6	84.8	93.9***	92.4
Eats one or more low-fat/non-fat foods	43.9	22.7	87.9***	34.8*
Place of meals				
Home	58.6	63.2	72.0***	71.6**
Fast food restaurants	16.2	11.6	8.7***	6.6***
Restaurant food[d]				
Burgers	36.3	16.6	9.1***	6.0
Mexican food	31.8	21.1	15.1**	12.0**
Pizza	22.8	16.7	4.5***	6.0*
Fried chicken	15.1	7.5	1.5***	7.6**

[a]N = 66.
[b]Includes low-fat margarine/butter, canola oil, and olive oil.
[c]Includes stick margarine/butter, soft tub margarine, lard/bacon fat, shortening, and vegetable oil.
[d]Percentage consuming once or more weekly.
***$P<0.001$, **$P<0.01$, *$P<0.05$ for significant differences at week 8.

Table 3.7. Physical activity pre- and post-intervention in mothers and children

Category	N	Week 0	Week 8
Mothers[a]	84	6024.0	9869.0***
Children[b]	87	4.2	4.5*
Boys	43	4.4	4.7[t]
Girls	44	4.0	4.2[t]
1 year olds	46	3.9[t]	4.3**
2-3 year olds	41	4.5[t]	4.6
Healthy weight[c]	67	4.3	4.4
At risk/overweight[c]	20	4.0	4.8***

[a]Three-day average of steps as measured via pedometers.
[b]Based on the activity scale of the Toddler Behavior Assessment Questionnaire. Maximum score possible is 7.
[c]Controlled for child age and sex.
****P<0.001, **P<0.01, *P<0.05* for significant differences from week 0.
[ttt] *P<0.001,* [tt] *P<0.01,* [t] *P<0.05* within categories with same superscript.

DISCUSSION

This study suggests that mothers can act as positive agents of change to improve diet and activity behaviors in their 1-3 year olds. We found that mothers who modify their food choices and fat habits made comparable changes for their child. Others have reported correspondence between mother and child for nutrient intakes (Oliveria et al. 1992, Vauthier et al. 1996) and food preferences (Fisher et al. 2002, Lee and Birch 2002, Skinner et al. 1998, Skinner et al. 2002). As a consequence of the mothers participating in this program, their child's diet improved, as indicated by reduced calories, fat, sweetened beverages and fast food consumption, and increased home-prepared meals.

Decreased caloric consumption also was seen after an intervention for 43 overweight/obese, Native American mothers of 9-month to 3-year-olds (Harvey-Berino and Rourke 2003). In their obesity parenting support program, energy intakes of children's diets diminished 26%, as compared to declines of 16% and 9% in our overweight/at risk and healthy weight children, respectively. These reductions of energy intake in our children appear to be warranted, as 22% were overweight/at risk, and the final caloric intakes remained at, or slightly above, the EERs .

Total/saturated fat diminished post-intervention, but total fat remained within the recommendation of 30-40% of energy for children, presumably due to substitution of high-fat snacks/desserts, fast foods, and added fats with lower-fat choices. The problem with consumption of high-fat foods is that it may lead to a learned preference (Ricketts et al. 1997) and contribute to cardiovascular disease risk and obesity. Several investigators have reported a positive relationship between total/percent energy from fat and child fatness in preschool (Newby et al. 2003, Nguyen et al. 1996, Klesges et al. 1995, Robertson et al. 1999). Thus, interventions should promote moderation of total fat to 30-40% of energy and balance of high- and low-fat foods in diets of children.

Our program was successful at curtailing the intake of sweetened beverages. Excessive amounts of these beverages have been linked to obesity in school-age children and adults (Bray et al. 2004, Ludwig et al. 2001, Nicklas et al. 2003), but not in our sample of 1-3 or 2-5 year olds by Newby et al. (2004). This lack of association may be due to the young age, as intakes of sweetened beverages may be limited. For example, frequency of sweetened beverages was lower in this investigation (2.4 oz/day) and that by Newby et al. (2004) (3.1 oz/day), both of which used FFQs, as compared to Rampersaud et al. (2003) who utilized 24-hour recalls (5.7 oz/day). Although the link to obesity at this age may not be apparent, sodas/fruit drinks/ades may displace more nutritious beverages (Harnack et al. 1999, Skinner et al. 2004).

One behavioral change observed was consumption of more home-prepared meals, with fewer visits to fast food restaurants, in both mother and child. These modifications should improve nutritional adequacy of diets, as fast foods are associated with excess calories and fat, and less milk, fruit, and vegetables (Bowman et al. 2004, Paeratakul et al. 2003). Also, home-prepared meals have been reported to be more nutritious (Gillman et al. 2000, Neumark-Sztainer et al. 2003).

The most frequently eaten foods by our children were analogous to other studies of 1-2 year olds in the Feeding Infants and Toddlers Study (Fox et al. 2004) and 1-3 year olds in the Continuing Survey of Food Intakes by Individuals (US Department of Agriculture 1999). Thus, the types of foods selected by toddlers do not appear to differ by socioeconomic status.

Crawford and Shapiro (1991) found that physical inactivity was related to obesity as early as 6-months of age, and the association remained throughout childhood. Klesges et al. (1995) documented that initial aerobic and increases in leisure exercises correlated negatively with BMI in a 3-year longitudinal investigation of 146 preschool children. Their results suggest that physical activity may protect against adiposity at a young age. As a consequence of our program, activity scores improved, particularly among overweight children. Harvey-Berino and Rourke (2003) also assessed physical activity in an intervention with a similar age group that targeted mothers, but they did not observe increased activity in children. However, an accelerometer was used to assess activity; whereas, we used an activity scale whose limitations are recognized. Nonetheless, we believe that an emphasis on activity should be instituted at a young age to develop early patterns of active lifestyles.

Mothers increased activity, but it was not correlated within mother-child pairs. This finding is similar to that observed in 3-5 year olds (Trost et al. 2003) and 5-year-old girls (Davison and Birch 2001). This association was positive only in older children 4-7 (Moore et al. 1991) and 7-12 years old (Fogelholm et al. 1999). Perhaps, parental activity is less influential at younger ages when children's activity levels are typically high.

Quantities of fruits, vegetables, and whole grains in the children's diets were sub-optimal throughout our program, despite intense efforts to encourage greater inclusion. We observed that mothers were more likely to eliminate foods deemed unhealthy, rather than to incorporate more nutritious choices. Presumably, the lack of improvement in vegetable intake of children was related to similar inadequacy in the mothers. Vegetable intakes have been reported to fall below Food Guide Pyramid recommendations in another study of ethnically diverse, low-income mothers (George et al. in submission). Similarly, Epstein et al. (2001) did not find an increase in fruits and vegetables in 6-11 year old, non-obese children with obese parents participating in a 6-month intervention to improve eating behaviors. In contrast, Koblinsky et al. (1992) did document a rise in fruits and vegetables in 1-5 year old children following a nutrition education program for Head Start parents. Thus, immediate enhancement of fruit and vegetable consumption in children with mothers as role models may be challenging.

Nutrients below the DRI in children's diets were folate, fiber, and vitamins A, D and E. The inadequacy of these nutrients from dietary sources was not ameliorated by supplements, as only 10% of the mothers gave their child vitamins/mineral pills on a regular basis. Quantities of these nutrients were comparable to, or slightly lower than, data reported by others (Alaimo et al. 1994, Devaney et al. 2004, Nolan et al. 2002, US Department of Agriculture 1999). In contrast, a large percentage of children had values above ULs for niacin (47.3%) and zinc (27.5%). Devaney et al. (2004) also noted large proportions above the UL for zinc in their 1-2 year olds.

A limitation of the intervention was the lack of a control group in children; therefore, the subjects served as their own controls. In addition, there is a need for longer-term follow up of eating habits and anthropometrics to examine the sustainability of behavioral changes. These techniques should be incorporated into future studies of weight loss using low-income mothers as agents of change.

CONCLUSIONS

Targeting mothers as agents of change to improve diet and activity behaviors of their young children appears to be effective. Overweight/obese mothers who modify their food choices and fat habits will most likely make comparable alterations for their child.

The offer of a free weight loss class was a successful method of enticing low-income women to participate in an educational intervention that benefited their children. The most highly rated aspects of this program were its interactive learning components (i.e. wearing pedometers, cooking demonstrations) and group support. Thus obesity interventions should emphasize an abundance of hands-on activities, rather than just knowledge dissemination.

Peer educators who have been successful in the weight loss program may be the most feasible, cost-effective means for the delivery of these programs in the community. Effective strategies for the implementation of these weight loss interventions in public health settings are needed.

A problem encountered was that mothers focused on eliminating foods considered unhealthy, rather than increasing more nutritious foods. Thus, emphasis should be placed on positive messages that stress inclusion of all foods in moderation, without labeling items as “good” and “bad” (Freeland-Graves and Nitzke 2004).

Chapter 4: Mother's Weight and Child's Activity and Percent of Energy from Carbohydrate Impact Weight-for-Height in Children Ages 1-3 Years

ABSTRACT

Objective: To determine the relationship of demographic, physical, child's dietary, and mother's psychosocial factors on weight-for-height in 1-3 year old children of overweight/obese, low-income mothers.

Design: A convenience sample of mothers and their child were measured for height and weight. Mothers completed demographic, health history, dietary, physical activity, knowledge/attitudes, and psychosocial questionnaires on one occasion.

Subjects/Setting: Participants (n=101) were recruited from the Special Supplemental Program for Women Infants and Children (WIC) and public health clinics. Subjects were a tri-ethnic sample of low-income, overweight/obese mothers of children 1-3 years.

Statistical Analyses Performed: Analysis of covariance determined differences in continuous variables by categorical variables. Partial correlations measured the relationships between continuous variables and child weight-for-height. Child age and gender were controlled for in all analyses. Multiple regression (hierarchical) was used to calculate the variance in weight-for-height explained by physical, demographic, dietary, and psychosocial factors.

Results: Greater child weight-for-height was related to modifiable factors, including greater mother's weight, and child's inactivity and lower percent of energy from carbohydrate. These variables explained 16% of the variance in weight-for-height. Non-modifiable factors (family history of diabetes and child's age) accounted for an additional

13% of the variance. Other demographic and psychosocial variables were unrelated to weight-for-height in this sample.

Conclusions: Weight loss interventions for overweight/obese mothers should be a primary focus in the prevention of obesity in young children. The enhancement of child's activity level and consumption of complex carbohydrates (with a simultaneous decrease in energy from fat) may be effective strategies for obesity prevention in 1-3 year olds.

INTRODUCTION

Child obesity is paralleling the obesity epidemic in adults and becoming one of the most significant health problems in young children. Data from NHANES IV reveal that 11% of 0 – 23 month olds and 10% of 2 – 5 year olds are classified as overweight, as compared to 9% and 7% seen in NHANES III (Ogden et al. 2002). In addition, 12% of 2-5 year olds are at risk for overweight (Hedley et al. 2004). These rates are disproportionately higher in 0 – 23 month old African American (Ogden et al. 2002) and 2-5 year old Hispanic (Hedley et al. 2004) children. The perception that these children will "grow out" of their obesity may not be true, as many obese children retain this status as adults (Rossner 1998). Thus, the identification of significant factors contributing to obesity development in young children is critical for early prevention strategies.

The etiology of child obesity is complex and related to a multitude of determinants. Non-modifiable factors are determinants that cannot be changed but can identify at-risk children. Some examples are: family history of diabetes (Basit et al. 2003, Giampietro et al. 2002), greater infant birth weight (Gillman et al. 2003, Hediger et al. 1999, Melgar-Quinonez and Kaiser 2004, Sherman et al. 1995), Hispanic (Hediger et al. 2001, Sherman et al. 1995) or African American ethnicity (Strauss and Knight 1999), single-mother families (Gerald et al. 1994, Sherman et al. 1995), lower maternal education (Baughcum et al. 2000, Moussa et al. 1994), low socioeconomic status (Liu et al. 2002, Sherman et al. 1995), and method of infant feeding (Grummer-Strawn et al. 2004, Hediger et al. 2001, von Kries et al. 2000).

Modifiable factors that can be changed represent the focus of current public health strategies to combat the obesity crisis. These include maternal obesity (Gyovai et al. 2003, Melgar-Quinonez and Kaiser 2004, Stettler et al. 2002, Whitaker et al. 2004);

maternal (Fogelholm et al. 1999, Moore et al. 1991) and child (Crawford and Shapiro 1991, Klesges et al. 1995, Moore et al. 1995) inactivity; greater child's % energy from fat/total fat (Davison and Birch 2001, Newby et al. 2003, Nguyen et al. 1996, Tucker et al. 1997) and excess caloric intake (Gillis et al. 2002, Tucker et al. 1997); and lack of nutrition knowledge (Sherman et al. 1995) and social support in the caretaker (Gerald et al. 1994).

The purpose of this study is to assess factors related to greater weight-for-height in 1-3 year old children of low-income, overweight/obese mothers. These will include demographic, physical, child's diet, and mother's psychosocial influences.

METHODS

Design of Study

A tri-ethnic sample of mothers and their 1-3 year old child (n = 101) were measured for height/length and weight at one visit. Mothers completed a demographic/health history, child dietary questionnaires (24-hour recall, 2-day diet records, and food frequency questionnaire), Toddler Behavior Assessment Questionnaire (TBQ), Nutrition Knowledge, Nutrition Attitudes, and psychosocial questionnaires (stress, social support, weight efficacy, body image, depression).

Determination of Weight Status

Height in mothers and children ≥ 2 years old was determined with a stadiometer (Perspective Enterprises, Portage, MI) at a clinic. Weight of mothers and children able to stand on a scale was assessed using a calibrated electronic scale (Model HS-100-A, Fairbanks Scales, St. Johnsbury, VT). Shoes and heavy clothing were removed. If the child was too young to stand on the scale alone, the child was weighed with the mother and her weight subtracted. Recumbant length of children < 2 years was measured by lying the child on a flat surface with a tape measure securely adhered. The head of the child was positioned straight and all the way up against a wall, and the feet at a 90° angle to the leg. Two trained personnel aided in the measurement, one to keep the head from moving, and the other to align the leg and stabilize the feet. A mark was placed on the tape measure at the bottom of the heel.

Body mass index (BMI) was calculated from height and weight (kg/m^2) for mothers. Recumbent length was measured in children < 2 years and standing height in children ≥ 2 years. NutStat, a nutrition anthropometry program within the EpiInfo computer program (Epi Info™ 2002 Revision 2), was used to calculate weight-for-length

(1 year olds) or weight-for-stature (2-3 years) percentiles using the 2000 Centers for Disease Control and Prevention (CDC) growth charts. Collectively, these comprise the weight-for-height percentile levels in this study. BMI-for-age is the most commonly used method for assessing overweight/at risk in children ≥ 2 years; however, no differences were found when using weight-for-height versus BMI-for-age to detect overweight or underweight in children 2-19 years (Mei et al. 2002). Thus, in this study weight-for-height was used for all children, and those < 5^{th} percentile were classified as underweight; 5^{th} - 95^{th}, as normal weight; and > 95^{th}, as overweight.

Subjects

Participants (Hispanic, African American, and Caucasian) were recruited from Special Supplemental Women Infants and Children (WIC) and public health clinics. Mothers were ≥ 18 years of age, had a combined family income < 200% of the federal poverty level, were literate in English, and had a 1-3 year old child. Mothers were informed of the benefits and risks of the study and informed consent was obtained. The Institutional Review Board of the University of Texas at Austin approved the study.

Of the initial 110 participants, nine were removed from the analyses as they did not complete all questionnaires, for a final sample size of 101. There were no significant differences in anthropometric or demographic characteristics of the dropout subjects or their children.

Demographics/Health History

A 33-item general questionnaire was used to collect information on age, income, education, ethnicity, parity, childbirth, and employment status. Additional questions addressed mother and child health histories.

Nutrient Intakes of Children

Nutrient intake was measured via 24-hour recalls and 2-day diet records for children as recorded by mothers. A trained registered dietitian administered the 24-hour recall with measuring utensils and food models to help subjects determine portion sizes. Interviewers provided instructions for completion of an additional 2 days of food records, including one weekend day. Dietitians reviewed and clarified the diet records with the subject to ensure accuracy. Data from the recall and records were analyzed using Food Processor 7.71 (ESHA Research, Version 7.81, 2001).

Software for Intake Distribution Estimation (SIDE, version 1.0, 2002) was used to remove within-person, day-to-day variation in nutrient intake in order to obtain better estimates of usual intake. Nutrient data presented was adjusted by SIDE and does not include supplements. All children had plausible intakes of energy (500 - 3000 kcals).

Food Choices of Children

Food choices of children were assessed with a food frequency questionnaire (FFQ) developed and tested for reliability and validity in mothers of 1-3 year old children (Klohe et al., in press). The instrument was completed by the mother for her child and based on a semi-quantitative FFQ developed and validated for tri-ethnic adults (George et al. 2004). Both adult and child FFQs were derived from the Health Habits and History Questionnaire (HHHQ) (Block et al. 1992), but were extensively modified to include ethnic foods, low-fat foods, restaurant/fast foods, functional foods and nutritional supplements. The child FFQ was further modified to include age-appropriate foods and portions. Mean coefficients were 0.69 for test-retest reliability and 0.41 for concurrent validity against diet records.

The frequency section of the questionnaire included nine response options, ranging from "never or < once per month" to "2 + servings per day." A small serving was designated as ½ the medium; a large, 1 ½ times the medium; and an extra large, 2 times the medium serving provided. FFQs were checked by a registered dietitian to ensure accuracy. The nine frequency response options were recoded into fractions of servings/day and serving sizes recoded into multiples of a medium serving. Servings/day of the food items were computed by multiplying the frequency and portion size and grouped into categories based on similarity of nutrient content.

Physical Activity of Mothers

Physical activity in mothers was detected via a 3-day average of steps/day assessed with pedometers (Model AE170, Accusplit, San Jose, CA). This Accusplit AE170 model is equivalent to the Yamex Digiwalker SW-701, but sold under a different manufacturing label. Reliability and validity of the Yamex Digiwalker has been established (Bassett 1996, Hendelman et al. 2000, Schneider et al. 2004) and shown to exhibit concurrent validity with steps during walking (r=0.84) and VO_2 max (r=0.75) (Hendelman et al. 2000).

Physical Activity of Children

Physical activity in children was measured via an activity scale of the Toddler Behavior Assessment Questionnaire (TBAQ). The full questionnaire consists of 108 items to measure temperament; we only used the 7-item activity scale. This questionnaire demonstrated acceptable validity with parents of toddlers, with a Cronbach's α for the activity scale of 0.71 (Goldsmith 1996). Activity level was defined as "limb, trunk, or locomotor movement during a variety of daily situations, including free play, confinement, or quiet activities." A 7-point response scale was used, with values ranging from 1 (never) to 7 (always observed the behavior during the last two weeks). A “does not apply” option was available. Values were summed and divided by the total number of items with responses to create a total score.

Nutrition Knowledge of Mothers

Nutrition knowledge was assessed via a 25-item test, developed and psychometrically evaluated by Klohe et al. (in submission). The following areas of interest were tested: weight loss; prenatal nutrition; child nutrition; the Food Guide Pyramid; and sources/functions of macronutrients, vitamins, and minerals. Correct responses were given a “1” and incorrect a “0” and the number correct were tallied to compute total score. A higher score indicates more questions answered correctly.

The Kuder Richardson’s KR-20, which is a more conservative estimate than Cronbach’s alpha (McDonald 1999), was 0.6. Thus, this test demonstrated acceptable reliability. An excellent content validity index was achieved (CVI = 100%) and discriminant validity established, as scores of the mothers were found to be significantly lower than those of nutritional science Ph.D. students ($p<0.001$).

Nutrition Attitudes of Mothers

Motivators for eating (3 items), emotional eating (3 items), barriers to healthy eating (6 items), and healthy eating characteristics (9 items) were identified using a 21-item nutrition attitudes questionnaire validated by Hanss-Nuss et al. (2002). A 7-point response scale was used, with values ranging from 1 (least important) to 7 (very important). For the emotional eating subscale only, values ranged from 1 (never) to 7 (always). As necessary, items were reverse coded so that a mean value for each subscale could be determined. Higher scores represent more of the particular attitude. Cronbach’s α for reliability were 0.65 for motivators for eating, 0.80 for emotional eating, 0.78 for barriers to healthy eating, and 0.86 for health eating characteristics.

Stress of Mothers

An 11-item scale with 4-point response options ranging from 1 (no stress) to 4 (severe stressor/hassle) was used to determine the occurrence of stressors such as financial worries, family, friends, moves, losses, abuse, and overload. A mean total stress score was calculated, with a higher value indicating more stress. Cronbach's α for reliability in postpartum mothers was 0.73 (Walker 1997). Validity has been established for a prenatal (Curry et al.1994) and postpartum tri-ethnic sample of mothers (Walker 1997).

Social Support of Mothers

A 6-item scale was administered to measure postpartum social support. Response options ranged from 1 (not at all) to 9 (completely). A mean total social support score was calculated, with a higher value indicating more support. The scale exhibited a Cronbach's α of 0.87 (Walker 1997) and has been validated in a postpartum, tri-ethnic sample of mothers (Walker 1997).

Weight Efficacy Life-Style of Mothers

A 20-item questionnaire developed and validated for obese adults (Clark et al. 1991) was used to assess self-efficacy in weight management in five situations: negative emotions, availability, social pressure, physical discomfort, and positive activities. Response options ranged from 0 (not at all confident) to 9 (very confident that you can resist the desire to eat). Cronbach's α were 0.87 for negative emotions, 0.76 for availability, 0.90 for social pressure, 0.70 for physical discomfort, and 0.82 for positive activities (Clarke et al. 1991). Subscale scores or a total score can be computed, but only the total WEL score was used in this study. A mean total score for self-efficacy was calculated, with a higher value indicating more confidence.

Body Image of Mothers

A 34-item inventory, the Multidimensional Body Self-Relations Questionnaire, was used to examine body image. This questionnaire consists of five subscales: body areas satisfaction (satisfaction with body parts), overweight preoccupation (obsession with dieting, weight, and eating restraint), self-classified weight (perception of current weight), appearance evaluation (satisfaction with appearance), and appearance orientation (effort expended on appearance). A 5-point response scale was used with options from 1 (definitely disagree) to 5 (definitely agree). Mean values for each subscale were calculated, with a higher value representing more of the body image trait measured. Cronbach's α were 0.73 for body areas satisfaction, 0.76 for overweight preoccupation, 0.89 for self-classified weight, 0.88 for appearance evaluation, and 0.85 for appearance orientation. Validity has been established by Brown et al. (1990).

Depression of Mothers

A 20-item Center for Epidemiological Depression Scale was used to measure depressive symptoms. This scale has been developed and validated by Radloff (1977) and psychometrically evaluated in postpartum, tri-ethnic mothers by Walker et al. (1997). A 4-point scale was used with response options ranging from 0 (rarely) to 3 (most or all of the time). Values were summed to create a total depression score, with higher values indicating more depression. Cronbach's α was 0.90 in post-partum women (Walker et al. 1997).

Statistical Analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS 11.5, Chicago, IL, 2003). Frequencies, medians, and means were computed for descriptive purposes, and data were examined for outliers and normality.

Analysis of covariance was used to determine significant differences in continuous variables by categorical variables, controlled for child's gender and age. Partial correlations, controlled for child's gender and age, measured the relationship between continuous variables with child weight-for-height. Demographic, physical, dietary, and psychosocial factors with significant partial correlations or ANCOVAs ($p<0.08$) were entered into a multiple regression analysis (hierarchical) to determine the proportion of variance in child weight-for-height explained by these variables. Step 1 of the model included non-modifiable variables: family history of diabetes and child's age and gender. Step 2 of the model allowed for detection of additional variance explained by modifiable factors: mother's weight and nutrition knowledge score, and child's activity level and percent of energy from carbohydrate. Two mothers were missing nutrition knowledge scores and were not included in the model (n=99).

RESULTS

Participants were a tri-ethnic, convenience sample (65% Hispanic, and 22% African American, 13% Caucasian) of overweight (22%) and obese (78%) mothers of children, 1-3 years old. The predominance of Hispanics in this population matches the ethnic breakdown of the WIC and public health clinics where subjects were recruited. Age (x = 27 years) and BMI (x = 35 kg/m^2) of the mothers, and number of children/household (x = 2), did not vary according to ethnicity. Ethnicities of the child paralleled that of the mother, with the exception of those of mixed ethnicity (3%). The most frequently reported income and education were \$15,000-\$29,999 (54.5%) and partial college (38%), respectively. The mean weight-for-height of the children was 65$^{th\%ile}$, and 21% of children were classified as overweight (weight-for-height > 95th percentile).

Table 4.1 displays the demographic distribution according to child weight-for-height, controlled for child's gender and age. Children with a family history of diabetes had greater weight-for-height percentiles than who did not. No other significant differences were observed.

The relationship of physical, child's diet, and mother's psychosocial variables with weight-for-height controlled for child's gender and age is provided in Table 4.2. Child weight-for-height was associated positively with mother's weight and child's % of energy from fat, and negatively with child's age and % of energy from carbohydrate. Lower child inactivity (p=0.07) and maternal nutrition knowledge (p=0.06) approached significance. Other variables did not significantly influence weight-for-height.

Table 4.1. Demographic distribution according to child weight-for-height, controlled for child's gender and age[a]

Characteristic	**Frequency**	**Weight-for-height percentile[b]**	***P*[c]**
Mother			
Family history of diabetes			0.02
Yes	67	69.3 ± 3.4	
No	34	55.2 ± 4.8	
Income			0.19
< $15,000	26	72.0 ± 5.9	
$15,000 - $29,999	55	60.3 ± 3.9	
$30,000	20	69.7 ± 6.5	
Education level			0.47
< Partial high school	17	65.8 ± 7.1	
High school	33	64.2 ± 5.0	
Partial college	38	66.2 ± 4.6	
College or advanced degree	13	51.0 ± 8.6	
Living with a spouse/partner			0.66
Yes	74	63.2 ± 3.3	
No	27	66.1 ± 5.7	
Child			
Gender			0.61
Boy	50	66.0 ± 4.0	
Girl	51	63.1 ± 4.0	
Method of infant feeding received			0.36
Breast milk	23	55.9 ± 6.3	
Formula	27	66.9 ± 5.5	
Combination breast milk & formula	51	66.0 ± 4.1	

[a]N = 101
[b]Mean ± standard error
[c]Analysis of covariance

Table 4.2. The relationship of physical, child's diet, and mother's psychosocial factors with child weight-for-height, controlled for child's gender and age

Factor	N	Mean ± SE[a]	r[b]	*P*
Physical				
Mother's				
Weight, lbs	101	203.8 ± 4.6	0.28	0.005
Gestational weight gain, lbs	96	30.6 ± 2.1	0.08	0.46
Activity, pedometer steps	101	5936.1 ± 322.4	0.00	0.98
Age, yrs	100	27.3 ± 0.6	0.05	0.61
Child's				
Birth weight, oz	100	122.1 ± 2.1	0.11	0.28
Activity, score[c]	101	4.5 ± 0.1	-0.18	0.07
Age, yrs	101	2.0 ± 0.1	-0.23	0.02
Child's diet				
Dietary intake				
Calories, kcal	101	1264.0 ± 40.5	0.09	0.39
Total fat, g	101	47.7 ± 1.8	0.15	0.15
Energy from fat, %	101	33.8 ± 0.6	0.21	0.04
Saturated fat, g	101	19.4 ± 0.7	0.17	0.10
Energy from saturated fat, %	101	14.0 ± 0.3	0.17	0.09
Carbohydrate, g	101	166.4 ± 5.6	0.01	0.95
Energy from carbohydrate, %	101	52.8 ± 0.6	-0.24	0.02
Mono- and dissacharide, g	101	84.2 ± 3.4	-0.05	0.65
Complex carbohydrate, g	101	80.9 ± 3.5	0.05	0.62
Fiber, g	101	8.2 ± 0.4	-0.04	0.70
Protein, g	101	45.5 ± 1.7	0.13	0.20
Energy from protein, %	101	14.5 ± 0.3	0.08	0.44
Grains, servings	93	3.2 ± 0.2	-0.07	0.49
Vegetables, servings	93	1.9 ± 0.2	-0.12	0.27
Fruits, servings	93	3.1 ± 0.2	-0.05	0.62
Dairy, servings	93	2.9 ± 0.2	0.07	0.50
Meats/meat equivalents, servings	93	2.6 ± 0.2	-0.02	0.84
Sweetened beverages, servings	93	0.8 ± 0.1	-0.04	0.68
High fat snacks & desserts, servings	93	0.8 ± 0.1	-0.01	0.96
Fast food consumption, % of meals	93	11.8 ± 1.3	-0.10	0.36
Mother's psychosocial[d]				
Nutrition knowledge, score	99	15.5 ± 0.3	-0.19	0.06
Nutrition attitudes, score				
Negative factors				
Motivators for eating	101	5.3 ± 0.1	0.09	0.37
Emotional eating	101	4.4 ± 0.2	-0.02	0.87
Barriers to healthy eating	101	3.4 ± 0.1	-0.00	0.97
Positive factors				
Healthy eating characteristics	101	4.1 ± 0.1	-0.10	0.32
Stress, score	101	23.3 ± 0.6	0.02	0.82
Social support, score	101	33.4 ± 1.3	0.05	0.62
Self-efficacy in weight management	100	124.9 ± 2.6	0.11	0.28
Body Image				

Appearance evaluation	101	2.4 ± 0.1	0.04	0.66
Appearance orientation	101	3.5 ± 0.1	-0.08	0.42
Body area satisfaction	101	2.5 ± 0.1	0.08	0.44
Overweight preoccupation	101	3.1 ± 0.1	-0.02	0.86
Weight classification	100	4.5 ± 0.0	0.14	0.17
Depression	100	20.6 ± 1.1	-0.02	0.83

[a]SE = standard error
[b]Partial correlations
[c]Maximum score possible is 7. A greater score indicates more activity.
[d]Greater score indicates more of the trait measured.

Items were entered into a regression model if they exhibited a significant partial correlation ($p<0.08$) with child weight-for-height; the exception was the non-significant child's gender ($p=0.61$) (Table 4.3). Others have controlled for child's age and gender in their models (Klesges et al. 1995, Whitaker 2004). Percentage of energy from fat and carbohydrate were inter-correlated with each other; therefore, only one could be included a regression analysis. Of these, % of energy from carbohydrate was selected because of its higher partial correlation. The analysis for Step 1 of the model was for non-modifiable factors. These included family history of diabetes and child's age and gender. Family history of diabetes and child's age were significant, and these explained 13% of the variance in child weight-for-height. In step 2 the modifiable factors were added to the model, including mother's weight and nutrition knowledge score and child's activity level and percent of energy from carbohydrate. These accounted for an additional 16% of the variance in weight-for-height. Mother's weight and child's activity level and percent of energy from carbohydrate remained significant, but that of maternal nutrition knowledge did not. This final regression model explained 29% of the variance in child weight-for-height.

Table 4.3. Multiple regression model for child weight-for-height[a]

Model[b]	**B[c]**	**SE[d]**	**β[e]**	***P***	**R^2 Change**
Step 1: Non-modifiable factors					0.13**
Family history of diabetes	12.57	5.88	0.20	0.035	
Child's					
Age	-5.87	2.83	-0.19	0.041	
Gender	3.06	5.26	0.05	0.56	
Step 2: Modifiable factors					0.16**
Mother's					
Weight	0.16	0.06	0.26	0.007	
Nutrition knowledge score	-0.98	0.82	-0.11	0.23	
Child's					
Activity level	-7.37	2.92	-0.23	0.013	
% energy from carbohydrate	-0.83	0.42	-0.18	0.05	

[a]N = 99
[b]Total $R^2 = 0.29$, $P < 0.001$.
[c]Unstandardized regression coefficient.
[d]Standard error of the regression coefficient.
[e]Partial correlation coefficient for each variable associated with child weight-for-height.
** $P<0.01$

DISCUSSION

These results suggest that weight loss interventions for overweight/obese mothers can be a primary focus in the prevention of obesity in young children. The modifiable factors of greater maternal weight, and child's inactivity and lower percent of energy from carbohydrate, were related to higher weight-for-height percentiles in 1-3 year olds of obese, low-income mothers. Non-modifiable factors (family history of diabetes and child's age) were also significant, but less influential.

Obesity in the mother is a consistent predictor of childhood overweight/obesity at multiple ages: 0-8 years (Strauss and Knight 1999), 6 months-16 years (Crawford and Shapiro 1991), 3-5 years (Hediger et al. 2001, Sherman et al. 1995), and 4-17 years (Stettler et al. 2002). Three recent studies conducted with low-income preschool children also reported this to be true (Gyovai et al. 2003, Melgar-Quinonez and Kaiser 2004, Whitaker 2004). In a study by Whitaker (2004) nearly one-quarter of low-income children (n=8494) participating in WIC with obese mothers were obese by 4 years of age. Thus, maternal obesity is clearly a significant influence on weight-for-height in the child. Public health programs should target a reduction in the mother's weight, as diet and lifestyle changes in the mother may affect the child.

In our investigation, more active children had lower weight-for-height percentiles. This phenomenon has not been well-researched in young children because of the lack of accurate/consistent measures of activity. However, Crawford and Shapiro (1991) noted a weak inverse correlation between activity and obesity beginning as early as 6 months and continuing throughout childhood. Others have documented that higher levels of exercise prevented body fat/BMI gains in preschool children (Klesges et al. 1995, Moore et al. 1995). In contrast, Eck et al. (1992) and Robertson et al. (1999) did not find that exercise precluded weight gain in children; however, the children in their studies were slightly older. Therefore, the effect on physical activity on child obesity remains controversial. Nonetheless, the promotion of activity in families with young children may be an effective strategy for prevention in 1-3 year olds.

Children with lower percentages of energy from carbohydrate had greater weight-for-height percentiles in this research. A study by Tucker et al. (1997) reported an inverse relationship between percent of energy from carbohydrate and child adiposity, but this was conducted in older children (x = 9 years). These authors also found percent of energy from fat to be associated positively with weight, as seen in this investigation. It appears that a higher proportion of calories from carbohydrate may safeguard against child overweight in this population, a finding that is controversial in adults (Bravata et al. 2003, Freeland-Graves et al. 2004, Morin et al. 1999, Yang et al. 2003). Most research in preschool children has focused on the correspondence between intake of "fat foods" (Newby et al. 2003), total fat (Fisher and Birch 1995, Klesges et al. 1995, Nguyen et al. 1996, Robertson et al. 1999), and % energy from fat (Davison and Birch 2001, Klesges et al. 1995, Robertson et al. 1999) and excess child adiposity. In this study, however, absolute intakes of fat and saturated fat were not correlated with weight, and carbohydrate as a percent of energy explained more of the variance in weight-for-height than percent of energy from fat. Thus, carbohydrates in the form of whole grains, fruits, and vegetables should be promoted as an effective strategy for weight management in young children.

The relationship of non-modifiable factors (family history of diabetes and younger child's age) with child weight-for-height is not surprising, and confirms that found by others. While the impact of family history of diabetes on child weight has not been examined in early childhood, it has been linked to greater BMI in school-age children (Basit et al. 2003, Giampietro et al. 2002).

The decrease in weight-for-height percentiles with age in our study is due presumably to developmental behaviors (i.e. increased activity and food jags) that may contribute to the loss of body fat in toddlers. For example, recent data from NHANES IV documented a greater prevalence of overweight in 0-23 month olds than 2-5 year olds (Hedley et al. 2004, Ogden et al. 2002). In our research the mean weight-for-height %ile of the 1-year olds was the $69^{th\%ile}$, whereas in the 2-3 year olds it was the $59^{th\%ile}$ ($p = 0.07$).

Child's gender had no effect on child weight-for-age in our sample. According to NHANES IV data, overweight/at risk prevalence rates in 2-5 year old boys and girls were not significantly different (Hedley et al. 2004). This finding is in contrast to a study by Whitaker et al. (2004) in low-income preschoolers that reported males were more likely to be obese than females.

There was a trend for mother's with lower nutrition knowledge to have children with greater weight-for-height in this research. Sherman et al. (1995) also reported that lack of nutrition knowledge increased the likelihood that the children would be overweight in 377 Mexican American and Anglo mothers of preschool children (3-5 years) participating in WIC. Others have claimed that knowledge may be predictive of beneficial dietary behaviors (Harnack et al. 1997, Lozano et al. 1999, Parmenter and Wardle 1999, Torabi and Jeng 2001) which may protect against overweight.

A number of factors that were hypothesized to be related to child's weight were not observed in our sample. For example, nutrition attitudes, beliefs, and psychosocial characteristics of the mother did not impact weight-for-height. In contrast, Gerald et al. (1994) found that lower social support in caretakers was a correlate of greater child weight-for-height in children 2.5 – 5 years old. Larger infant birth weight (Hediger et al. 1999, Sherman et al. 1995, Whitaker 2004), Hispanic (Hediger et al. 2001, Sherman et al. 1995) or African American ethnicity (Strauss and Knight 1999), single-mother families (Gerald et al. 1994, Sherman et al. 1995), lower maternal education (Baughcum et al. 2000, Moussa et al. 1994), low socioeconomic status (Liu et al. 2002, Sherman et al. 1995), and method of infant feeding (Grummer-Strawn et al. 2004, Hediger et al. 2001, von Kries et al. 2000) have been affiliated with weight and/or fatness in young children. However, no associations were evident in our research.

Caloric intake also did not differ between overweight and healthy weight children in this study. This finding is in accordance with others who did not detect an association between energy intake and obesity in young children (Crawford and Shapiro 1991, Klesges et al. 1995). Although healthy weight and overweight children had similar energy intakes, the overweight children in this study were more likely to be less physically active. In contrast, Gillis et al. (2002) and Tucker et al. (1997) reported excess adiposity in older children with greater caloric intakes, suggesting the effect of energy consumption on child weight is more prominent at older ages.

Parental activity had no impact on child's weight-for-height in our population. In theory, parents who are more active may encourage their children to engage in exercise, protecting them against overweight development. Others have documented that parent and child levels were associated in 4-7 year olds (Moore et al. 1991) and 7-12 year olds (Fogelholm et al. 1999), but not in 3-5 year olds (Trost et al. 2003) and 5-year-old girls (Davison and Birch 2001). These results suggest that effect of parental activity is unclear and may have a stronger influence when the child grows older.

A limitation of this study is the lack of longitudinal data; thus causality cannot be determined. The relatively small sample size and the specific demographic of our population (low-income, tri-ethnic, overweight/obese mothers) limits the generalizability of the results.

CONCLUSIONS

Weight loss interventions for overweight/obese mothers may be an effective technique for the prevention of obesity in young children. These programs should emphasize physical activity and adequate consumption of carbohydrates to promote a healthy weight in children.

The modifiable factors of maternal obesity and child activity and percentage of energy from carbohydrate, and the non-modifiable factors of child's age and family history of diabetes can be used in public health and WIC clinics as screening criteria to identify at-risk children.

Demographics and maternal psychosocial characteristics did not appear to influence child weight-for-height in 1-3 year olds of exclusively overweight/obese, low-income mothers. However, future studies should address this relationship in other populations of young children.

Chapter 5: Nutrition Knowledge is Associated with Greater Weight Loss in Obese/Overweight, Low-Income Mothers

ABSTRACT

Objective: To examine nutrition knowledge of low-income, overweight/obese mothers with young children, and to determine whether gains in nutrition knowledge would promote more effective weight loss.

Design: A convenience sample of low-income mothers participated in an 8-week intervention emphasizing healthy eating, physical activity, and lifestyle changes for the family. Mothers and children were measured for height and weight and mothers completed demographic and nutrition knowledge questionnaires at weeks 0 and 8.

Subjects/Setting: Participants (n=141) were recruited from the Special Supplemental Program for Women Infants and Children (WIC), public health clinics, and elementary schools. Subjects were overweight/obese, tri-ethnic low-income mothers of children 8-months to 12-years old.

Statistical Analyses Performed: Paired-sample t-tests, repeated measures analysis of variance, and analysis of covariance were used to examine changes in pre-post test scores. Pearson correlations were computed between weight loss and knowledge score. Chi-Square statistic was used to compare correct/incorrect responses by responder category.

Results: This intervention improved the nutrition knowledge of mothers in all areas of interest. Participants who achieved successful weight loss (≥ 5 pounds) had greater nutrition knowledge on both pre- and at post-tests than those who did not lose weight. Responders appeared more cognizant of information about diet and health that is

presented in public health or WIC clinics and information related to weight loss. Overall, the weakest areas for all were weight loss, the Food Guide Pyramid, and macronutrients.

Conclusions: Weight management programs should include a strong component of nutrition education to alleviate knowledge inequalities and promote more effective weight control. Information about the Food Guide Pyramid, weight loss, energy nutrients, and vitamins/minerals should be incorporated into educational programs for low-income mothers.

INTRODUCTION

Obesity rates continue to rise in the United States, particularly in minorities (Flegal et al. 2002). In women 20-39 years old, 70% of African-Americans, 62% of Hispanics, and 49% of Caucasians are estimated to be overweight or obese (body mass index, BMI ≥ 25 kg/m^2 (Hedley et al. 2004). Among all ethnicities, women of lower socioeconomic status are 50% more likely to be obese than women from higher socioeconomic groups (U.S. Department of Health and Human Services 2001). In addition, the risk of becoming overweight increases by 60-110% for women who have had at least one live birth (Williamson et al. 1994).

The pervasiveness of obesity, particularly in low-income, minority mothers, suggests the need for interventions tailored for this population. One component of an effective weight loss program should be the improvement of nutrition knowledge. Lack of knowledge may contribute to the higher rates of obesity in the economically disadvantaged. For example, low-income caretakers with children were less likely to know about diet-disease associations, to use food labels, or to have low-fat, eating habits than those with higher incomes (Morton and Guthrie 1997). Thus, weight management curriculum for those with lower socioeconomic levels should be designed to increase awareness of basic nutrition and diet-disease links.

A number of studies have reported greater nutrition knowledge and weight loss following a nutrition education intervention (Agurs-Collins et al. 1997, Bruno et al. 1983, Domel et al. 1992a, Domel et al. 1992b, Jeffery and Wing 1995, Rhodes et al. 1996). Of these, only two studies were conducted in low-income women (Domel et al. 1992a, Domel et al. 1992b). In contrast, four other studies reported increases in nutrition knowledge but no weight loss (Bell et al. 2001, Braeckman et al. 1999, Elder et al. 2000, Howard-Pitney et al 1997). These conflicting results suggest that improving nutrition awareness may not always lead to better weight control. While knowledge is clearly a necessary component, the type of the curriculum, focus of the intervention (i.e. weight loss vs. reduction of dietary fat/cholesterol for cardiovascular disease), effectiveness of the instructor, and the learning motivation of the participant may influence its dissemination and utilization. The purpose of this study is to examine nutrition knowledge of low-income, overweight and obese mothers with young children and to determine whether gains in nutrition knowledge would promote more effective weight loss.

METHODS

Design of Study

Low-income, Hispanic, African American, and Caucasian mothers (n=141) participated in an 8-week nutrition and physical activity weight loss intervention. Mothers and children were measured for height and weight and mothers completed demographic and nutrition knowledge questionnaires at weeks 0 and 8 (pre- and post-intervention).

Subjects

Participants were recruited from elementary schools, Women Infants and Children (WIC) clinics, and public health clinics. All subjects were mothers of children 8-months to 12-years old, ≥ 18 years of age, had a combined family income < 200% of the federal poverty level, and were literate in English or Spanish. Mothers were informed of the benefits and risks of the study and informed consent was obtained. The Institutional Review Board of the University of Texas at Austin approved the study.

Calculation of Weight Status

A stadiometer (Perspective Enterprises, Portage, MI) was used to determine height in mothers and children ≥ 2 years. Mothers and children who could stand unaided on a scale were weighed using a calibrated electronic scale (Model HS-100-A, Fairbanks Scales, St. Johnsbury, VT) without shoes or heavy clothing. Mothers with a child unable to stand alone on the scale held their child, and their weights were subtracted out to obtain the child's weight. Recumbant length of children < 2 years was measured on a flat surface with a tape measure affixed. The head of the child was positioned perpendicular to, and up against a wall, and the ankles bent with feet at a 90° angle to the leg. Two trained professionals aided in the measurement. A mark was placed on the tape measure at the bottom of the heel.

BMI was calculated from height and weight (kg/m^2). Mothers were divided into two weight categories for comparison: 1) responders—those able to lose 5 lbs or more and 2) non-responders—those losing less than 5 lbs. A 5 lb weight loss was chosen for responder criteria since the mean weight loss for the sample was 5.4 lbs, and this classification allowed for a fairly equal division. Non-responders were further divided into "weight gainers" in order to examine the knowledge characteristics of those participants who gained weight versus those losing 5 lbs or more (responders).

In children ≥ 2 years old, BMI-for-age percentiles were estimated using growth charts from the Centers for Disease Control and Prevention (Kuczmarkski et al. 2002). Underweight was classified as $< 5^{th}$ percentile; normal weight as $\geq 5^{th}$ and $< 85^{th}$; at risk for overweight as $\geq 85^{th}$; and overweight/obesity as $\geq 95^{th}$. In children < 2 years old, weight-for-length was used instead of BMI-for-age, with children $< 5^{th}$ percentile labeled as underweight; 5^{th} - 95^{th}, as normal weight; and $> 95^{th}$, as overweight.

Development of the Nutrition Knowledge Test

A 25-item test (final version) measured nutrition knowledge of mothers at weeks 0 (pre-) and 8 (post-intervention). Areas of interest included: weight loss, prenatal nutrition, child nutrition, the Food Guide Pyramid, sources and functions of macronutrients, and food sources/functions of select vitamins and minerals. Originally, the test was 30 questions and included 20 multiple choice and 10 true/false questions. Content validity of the 30-item test was determined via nutrition experts who reviewed the items for readability and item difficulty, appropriateness, bias, and correctness. An additional eight experts rated the individual questions for relevance to seven different areas of interest (the above six areas previously mentioned, plus heart disease).

Acceptable agreement (70-100%) was achieved for all questions, except one, yielding a content validity index (CVI) of 96%. This item was removed from the questionnaire as it also performed poorly in the reliability analysis.

Kuder Richardson's KR-20 was used to determine internal consistency reliability of the 30-item test because it is preferred for use with dichotomous variables (i.e. correct vs. incorrect). The KR-20 for the initial 30-item test was 0.56; thus three questions on heart disease and one on Olestra side effects were removed from the test to improve reliability. The final 25-item test administered had six areas of interest with a CVI of 100% and a KR-20 of 0.6. Since KR-20 produces more conservative estimates than Cronbach's alpha (McDonald 1999), a good scale would have a KR-20 of at least 0.6.

Discriminate validity was established by comparing scores of a sample of mothers (n=92) to scores of nutritional science PhD students (n=11). An independent samples t-test revealed that advanced nutrition graduate students performed significantly better than the mothers, with mean scores of 92% and 56%, respectively ($p<0.001$). This disparity indicated that the questionnaire could successfully differentiate between those with lower and higher levels of knowledge.

The questionnaire also was translated and back-translated into Spanish and evaluated for readability by two different bilingual speakers. Only seven participants needed the Spanish version of the knowledge test.

Demographics Questionnaire

A 33-item general questionnaire was used to obtain information on age, income, education level, primary language, parity, childbirth, employment status, job satisfaction, and family problems. Additional questions asked about current practices to lose weight, such as skipping meals, and previous attendance at childbirth classes.

Description of the Weight Loss Program for Mothers

Weight loss classes for mothers consisted of dietary, activity, and behavioral changes. A series of eight weekly classes were taught by registered dietitians. Classes in Spanish were taught bilingually and separately from those in English. In the 2-hour classes a variety of topics were discussed. Some examples included: weight loss and exercise goals, personalized meal plans and menus, calorie content of various foods, types/sources/health effects of fats, low-fat cooking demonstrations, child nutrition, stress reduction, emotional eating, and tips for eating healthy when short on time. Further details of the intervention are provided in Clarke et al. (in submission) and Klohe et al. (in submission).

The weight loss program was modeled after the Social Cognitive Theory (SCT). According to this theory, health behaviors can be attributed to an interaction between an individual's environment, behaviors, and cognitions. Change in any one of these areas may alter health behaviors (Bandura 1977). This intervention was designed to improve knowledge (cognition) of general health and nutrition and facilitate practice of behaviors (behavioral capability), thereby promoting healthy changes in diet and activity for weight loss.

The dietary component was based on healthful, well-balanced eating plans that promoted a 500 calorie deficit for weight loss, discussion of health benefits of foods/nutrients, and development of meal planning skills using the Food Guide Pyramid and the Food Guide Pyramid for Young Children. The role of physical activity in weight loss was discussed, as well as techniques to increase the amount and type of exercise. Mothers also were given examples of activities to do together with their child.

In addition, several other cognitive-behavioral strategies were used. Mother's self-monitored their diet with diet recalls and records and exercise with pedometers to measure steps and calories. Participants identified specific situations that promoted over-eating and appropriate solutions (stimulus control). In-class prizes were given and participants were encouraged to reward themselves for achievements (contingency management).

Statistical Analysis

Data were analyzed using SPSS (Statistical Software Package for the Social Sciences, SPSS, version 11.5, 2002, Chicago, IL). Frequencies and means were computed for descriptive purposes. Paired-samples t-tests examined overall changes in scores pre- and post-intervention. Repeated measures analysis of variance (ANOVA) assessed differences in pre-post scores by demographic/anthropometric variables and weight category. Initial statistical models using ANCOVA were formulated that included pre-test scores, ethnicity, education level, and income as fixed factors and covariates. Only pre-test scores significantly impacted post-test scores; therefore, post-test scores were controlled for differences in pre-test scores only. The adjusted post-test scores calculated by ANCOVA are listed aside the unadjusted scores. Chi-square statistics were used for comparisons of categorical data (e.g. differences among those scoring correctly or incorrectly on individual questions by weight loss categories). Pearson correlations examined relationships between test scores and continuous demographic data (BMI, weight loss).

RESULTS

The 141 participants were a tri-ethnic sample of mothers (67% Hispanic, 18% African American, and 15% Caucasian) (Table 5.1). Of these, 21% were overweight and 79% were obese. Age (x = 28 years) and BMI (x = 35 kg/m^2) of the mothers and number of children per household (x = 2) did not vary according to ethnicity. The majority of participants reported incomes $15,000-$29,999 (46%). The most frequent education level attained was partial college for African Americans (40%) and Caucasians (38%); for Hispanics, high school graduate (33%). Ages of children ranged from 8-months to 12-years; with Caucasians slightly younger than the Hispanics. In this sample 28% of the children were classified as overweight (20%) or at risk (8%).

Responders (≥ 5 pound weight loss) did not differ in education, income, or any other demographic factors from non-responders (< 5 pound weight loss) or weight gainers. However, a larger percentage of Caucasians (76%) were responders than Hispanics (43%) and African Americans (36%) ($p<0.05$), and non-responders were more likely to be living alone ($p<0.05$). Weight gainers had more children in the household ($p<0.05$), weighed less pre-pregnancy ($p<0.05$), and were more likely to skip meals ($p<0.05$) and less likely to be Caucasian ($p<0.05$).

Nutrition Knowledge

Changes in nutrition knowledge before and after the intervention are shown in Table 5.2. Caucasians scored significantly higher than African Americans and Hispanics at pre-test, but only higher than Hispanics at post-test. The ethnic disparity disappeared after controlling for differences in pre-test scores. Within ethnicities, Caucasians increased their nutrition knowledge by 11%; Hispanics, 20%; and African Americans, 36% ($p<0.05$, between African Americans and Caucasians/Hispanics). Scores increased

Table 5.1. Sample characteristics

Characteristic	Hispanic	African American	Caucasian
Mothers			
Age (y)	28.2 ± 5.9	28.6 ± 6.9	28.5 ± 6.2
BMI (kg/m^2)	35.7 ± 6.5	33.9 ± 7.2	33.0 ± 7.5
Number of children	2.4 ± 1.3	2.0 ± 0.9	2.1 ± 1.2
Children			
Age (y)	3.2 ± 2.9*	2.5 ± 1.6	1.5 ± 0.9*
Weight category[a]			
Overweight/at risk	26 of 95 (27)	9 of 25 (36)	4 of 21 (19)
Healthy weight	69 of 95 (73)	16 of 25 (64)	17 of 21 (81)

[a]According to growth charts from the Centers for Disease Control and Prevention (Kuczmarkski et al. 2002). The number in parenthesis represents the percentage.
**P<.05* between ethnicities.

Table 5.2. Nutrition knowledge test scores before and after the weight loss intervention

		Score, %		
Category	**N**	**Pre-test**	**Post-test**[a]	**Adjusted post-test**[b]
All	141	60	72	
Ethnicity				
African American	25	56^{***}	76	76
Caucasian	21	$72^{***,+}$	80^{**}	76
Hispanic	95	60^{+}	72^{**}	72
Education level				
Less than junior high	12	$52^{***,**,*}$	$60^{**,x,y,z}$	$64^{*,x,y,z}$
Partial high school	20	$56^{x,\gamma}$	$72^{**,t}$	72^{*}
High school graduate	43	$60^{*,z}$	76^{x}	76^{x}
Partial college	48	$64^{**,x}$	$76^{y,t}$	76^{y}
College/graduate degree	18	$68^{***,\gamma,z}$	80^{z}	76^{z}
Method of infant feeding				
Breast milk	29	$68^{**,*}$	76^{*}	72
Formula	49	56^{**}	72^{*}	72
Combination of formula and breast milk	63	60^{*}	76	76
BMI categories				
BMI 25.0 – 29.9	30	64	80	76
BMI 30.0 – 34.9	48	60	72	72
BMI ≥ 35.0	63	60	72	76
Child's weight status				
Normal weight	102	56	72	72
Overweight or at risk	39	64	76	76

[a]Post-test scores for all subgroups higher than at pre-test ($P<.05$).
[b]Adjusted for differences in pre-test scores (ANCOVA with pre-test as a covariate).
^{*,x,y,z,t}*P<.05,* $^{**,\Upsilon}$*P<.01,* $^{***,+}$*P<.001*, within groups in the same column with the same superscript.

as years of formal education increased. At pre- and post-test, those with less than a junior high school education, with incomes below \$15,000, and having Spanish as the primary language scored lower than those with higher education, income ($p < 0.01$), and speaking English ($p<0.01$).

Mothers who breastfed their child during infancy had significantly higher pre- and post-test scores than those who fed formula. No significant differences were observed pre- or post-test by BMI category; between mothers of healthy weight children versus overweight or at risk children; or age of children. Mothers who skipped meals had lower pre-test scores (56%) than those who did not miss meals (64%, $p<0.05$); by post-test this difference was no longer significant. Mothers who had attended childbirth classes had higher pre-test scores (68%) than those who did not (60%, $p<0.01$); at post-test both groups scored similarly. In addition, pre- and post-test knowledge was correlated negatively with number of children in the household ($r = -0.23$, $p < 0.01$), and post-test score was correlated positively with class attendance ($r = 0.24$, $p < 0.01$) and self-monitoring with the pedometer ($r = 0.27$, $p < 0.01$) and food records ($r = 0.26$, $p < 0.01$). Virtually all participants reported some form of stimulus control; thus, its relationship to knowledge could not be identified. Setting goals and rewarding for achievements was unrelated to knowledge.

At pre-test responders scored 14% and 23% higher than non-responders and weight gainers, and continued to do so at post-test (18% and 25%), respectively (Table 5.3). Women who lost more weight had higher pre-test ($r = 0.31$, $p < 0.001$) and post-test

Table 5.3. Test scores of subjects according to areas of interest

	Score, %			
	All	Responders	Non-responders	
Areas of Interest	(n = 141)	≥ 5 lbs weight loss (n = 66)	< 5 lbs weight loss (n = 75)	Weight gainers (n = 21)
All areas				
Pre-test	60	$64^{++,\varphi\varphi\varphi}$	56^{++}	$52^{\varphi\varphi\varphi}$
Post-test	72^{***}	$80^{***,+++,\varphi\varphi\varphi}$	$68^{***,+++}$	$64^{***,\varphi\varphi\varphi}$
Prenatal nutrition				
Pre-test	71	$78^{+,\varphi\varphi}$	65^{+}	$55^{\varphi\varphi}$
Post-test	84^{***}	$88^{*,\varphi\varphi}$	80^{***}	$64^{\varphi\varphi}$
Child nutrition				
Pre-test	69	$74^{++,\varphi\varphi}$	64^{++}	$59^{\varphi\varphi}$
Post-test	82^{***}	$87^{***,+++,\varphi\varphi\varphi}$	$77^{***,+++}$	$73^{**,\varphi\varphi\varphi}$
Vitamins & minerals				
Pre-test	66	67	64	58
Post-test	71^{**}	$75^{**,\varphi}$	68	62^{φ}
Macronutrients				
Pre-test	50	52	49	43
Post-test	66^{***}	$73^{***,++,\varphi}$	$60^{**,++}$	56^{φ}
Weight loss				
Pre-test	51	54^{φ}	47	42^{φ}
Post-test	67^{***}	$74^{***,++,\varphi\varphi\varphi}$	$61^{***,++}$	$48^{\varphi\varphi\varphi}$
Food Guide Pyramid				
Pre-test	44	$53^{++,\varphi\varphi}$	36^{++}	$29^{\varphi\varphi}$
Post-test	67^{***}	73^{***}	62^{***}	60^{**}

$^{***}P<.001$; $^{**}P<.01$; $^{*}P<.05$, within columns by areas of interest.
$^{+++}P<.001$; $^{++}P<.01$; $^{+}P<.05$, between responders vs. < 5 lbs weight loss, with the same superscript in rows.
$^{\varphi\varphi\varphi}P<.001$; $^{\varphi\varphi}P<.01$; $^{\varphi}P<.05$, between responders vs. weight gainers, with the same superscript in rows.

($r = 0.34$, $p < 0.001$, Figure 5.1) knowledge scores than non-responders. In addition, pounds lost were correlated with post-test knowledge of weight loss ($r = 0.25$, $p < 0.01$), macronutrients ($r = 0.25$, $p < 0.01$), child nutrition ($r = 0.21$, $p < 0.05$), and prenatal nutrition ($r = 0.21$, $p < 0.05$).

Mothers improved in all six areas of interest covered in the test (Table 5.3). At pre-test mothers were most cognizant about prenatal nutrition, child nutrition, and micronutrients; at post-test, these topics remained the strongest. The weakest sections (macronutrients, weight loss, Food Guide Pyramid) all showed the greatest improvements at post-test. Weight gainers increased significantly only in two areas at post-test: child nutrition and the Food Guide Pyramid. Post-test knowledge of responders was significantly higher than weight gainers in all categories, except the Food Guide Pyramid.

Table 5.4 displays individual post-test questions that were associated with successful weight loss. Responders were more likely to answer correctly on questions related to sodium, snacks for children, folic acid, food labels, calories, and carbohydrates in foods than weight gainers.

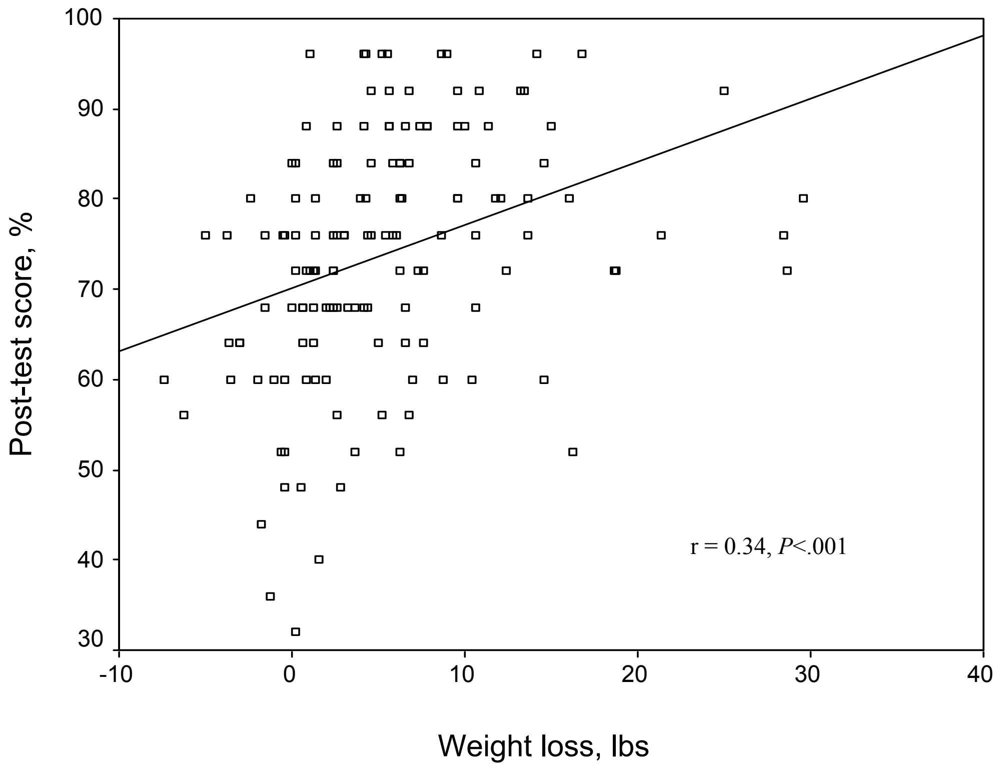

Figure 5.1. Weight loss correlated with post-test knowledge score.

Table 5.4. Post-test questions associated with successful weight loss[a]

Question	Score, %		
	Responders	Non-responders	
	≥ 5 lbs weight loss (n = 66)	< 5 lbs weight loss (n = 75)	Weight gainers (n = 21)
Canned soups, ham, and pickles are very high in: a. thiamin b. fiber c. zinc d. vitamin E **e. sodium**	$94^{*,**}$	80^{*}	71^{**}
Which of the following is the best snack for a small child? a. hot dog slice b. nuts c. popcorn d. whole grapes **e. sliced cheese**	$86^{*,**}$	71^{*}	57^{**}
Not enough ____ in the diet has been linked to birth defects involving the brain and spine (spina bifida). a. calcium **b. folic acid** c. iron d. vitamin A e. vitamin C	85^{**}	73	48^{**}
____ A food that is labeled "low-fat" always has fewer calories than the regular version of the food. **(False)**	85^{**}	72	57^{**}
If you were to decrease your food intake by 500 calories per day, how many pounds would you expect to lose in a week? **a. 1-2** b. 2-3 c. 3-4 d. 4-5 e. 5-6	73^{***}	60	29^{***}
Which food below does **NOT** contain carbohydrates? a. apple b. coke **c. hamburger meat** d. milk e. peas	$61^{*,*}$	43^{*}	33^{*}
A pound of fat equals about ____________ calories. a. 500 b. 1500 c. 2500 **d. 3500** e. 4500	$56^{*,*}$	36^{*}	24^{*}

$^{*}P<.05$, $^{**}P<.01$, $^{***}P<.001$ within rows with same superscript.

DISCUSSION

Successful weight loss was associated with greater nutrition knowledge in this study. Those mothers able to lose ≥ 5 pounds scored higher on both pre- and at post-tests than those who did not lose weight following an 8-week intervention. Responders appeared to be more cognizant of information about diet and health that is presented in public health or WIC clinics and information related to weight loss. Overall, the weakest areas were weight loss, the Food Guide Pyramid, and macronutrients.

These results are similar to those seen in other studies in low-income populations. Domel et al. (1992a, 1992b) administered weight management programs with a nutrition education component to 31 African American and 34 Hispanic low-income, overweight women. More weight change was found in the treatment versus non-treatment groups who received no nutrition education. After 11 weekly sessions, weight loss averaged 3.1 and 9 pounds in African American and Hispanics, respectively, and significant improvements in nutrition knowledge were seen (18% and 26%).

Four other interventions reported increased nutrition knowledge with weight loss, but in higher income populations. In a study by Jeffery and Wing (1995) knowledge increased in 177 slightly older (x = 37 years) obese subjects at the end of an 18-month behavioral weight loss program and at the 30-month follow up. Weight loss was correlated positively with knowledge at both time points. Rhodes et al. (1996) delivered a 3 month cholesterol education program to 49 men and 51 women at risk for coronary heart disease. BMI decreased by 1.1 kg/m^2, with a 17% improvement in nutrition knowledge in the dietitian-taught group. Another cholesterol reduction program in 145 worksite employees reported a 2.4% decline in percent ideal body weight, with a 19% increase on a nutrition information quiz (Bruno et al. 1983). In an intervention for 64 older African Americans, weight diminished 5 pounds in 6 months, with an 18% increase in knowledge (Agurs-Collins et al. 1997). Collectively, these studies support our finding that nutrition education can facilitate weight management.

In contrast, others have not documented weight loss even with improvements in nutrition knowledge. These interventions included dietary fat modification in 351 low-income participants (Howard-Pitney 1997), worksite cholesterol reduction in 272 men (Braeckman et al. 1999), a heart healthy initiative in 434 low-literate Latino adults (Elder et al. 2000), and fat and Food Guide Pyramid education for 365 Samoans (Bell et al. 2001). Thus, cognition does not necessarily translate into behavioral changes.

In this investigation, the degree of obesity did not influence baseline nutrition knowledge or subsequent weight loss. Burns et al. (1987) also reported that knowledge scores were comparable for obese and overweight subjects, but these subjects scored higher than healthy weight individuals. In addition, Allison et al. (1995) observed that obesity among African American women was not related to nutrition knowledge, as the obese correctly answered broad questions regarding health and diet. In our study knowledge was not indicative of better initial weight control, as pre-test scores of the healthy weight, overweight, and obese participants did not differ significantly.

Demographic characteristics present in our low-income population are comparable to previous investigations. Similarities include higher pre-test scores in Caucasians versus other ethnicities (Sapp and Jensen 1997, Sherman et al. 1995, Winkleby et al. 1994,); and in those with more formal education (Boulanger et al. 2002, Parmenter et al. 2000, Sapp and Jensen 1997,) and income (Harnack et al. 1998, Morton and Guthrie 1997, Parmenter et al. 2000). Nutrition knowledge is reported to be greater among those who speak English as their primary language (Boulanger et al. 2002); this finding was also seen in our study. In addition, our results compare favorably to others who found higher nutrition knowledge levels in households with fewer children (Boulanger et al. 2002, Ivanovic et al 1997, Morton and Guthrie 1997).

Breastfeeding, not skipping meals, and attending childbirth classes were all related positively to knowledge and were not associated with education, income, or weight status in this study. We have not identified literature that examined the relationship between nutrition knowledge and these behaviors. However, breastfeeding was associated with higher levels of formal education in 2,223 families in Canada (Dubois and Girard 2003), and skipping meals was greater among those with lower education and in the overweight subjects in a sample of 1431 adults trying to lose weight (Levy et al. 1993).

In this sample, 90% of mothers participated in the WIC program. Nutrition knowledge of the participants was not significantly different from non-participants at either time point, and both groups increased their knowledge scores post-intervention. Improvements in health related knowledge of WIC enrollees has been observed after completion of an intervention designed to enhance AIDS/HIV knowledge (Ashworth et al. 1994) and fruit and vegetable consumption (Havas et al. 1998, Langenberg et al. 2000). In addition, Havas et al. (1998b) found that awareness of the number of servings of fruits and vegetables required per day was predictive of fruit and vegetable intake in a study of 3,122 WIC participants. Thus, education of WIC mothers can promote specific health behaviors. In contrast, nutrition knowledge in this group may be lacking in some areas. For example, Gupta et al. (1999) reported that identification of iron-rich foods was poor, and WIC mothers with anemic children scored similarly to WIC participants of non-anemic children on questions related to good food sources of iron. These discrepancies indicate that nutrition knowledge in WIC mothers can be improved.

Maternal knowledge of nutrition was related inversely to child obesity in 189 Mexican-American and 188 Caucasian 3-5 year old children whose mothers participated in WIC (Sherman et al. 1995). We did not observe such a relationship; however, the children in our study were somewhat younger (x = 2.8 years).

Use of self-monitoring, but not stimulus control or contingency management (goal setting and rewards), was greater in those with higher nutrition knowledge. While no studies examining these relationships could be identified, participants most likely to improve their knowledge may have higher levels of motivation and may be more likely to apply techniques (i.e. self-monitoring) for successful weight loss.

In sum, low-income mothers had diverse levels of nutrition knowledge, but had similar improvements following an intervention. Successful weight loss was associated with higher baseline and post-test nutrition knowledge.

CONCLUSIONS

The relationship of nutrition knowledge to weight loss seen in this study suggests that weight management programs should include a strong component of nutrition education to alleviate knowledge inequalities and promote more effective weight control. In this study the majority of participants improved their knowledge scores as a result of the intervention. However, those with greater initial levels of nutrition knowledge were more successful at losing weight.

This population of primarily WIC mothers had the greatest knowledge of prenatal and child nutrition, suggesting that the WIC programs are successful in this area of their curriculum. But, information about the Food Guide Pyramid, weight loss, energy nutrients, and vitamins/minerals needs reinforcement in this low-income population.

Chapter 6: Conclusions and Recommendations

These results indicate that mothers can serve as agents of change for prevention of child obesity. We found that an educational weight loss program for mothers improved the diet and activity behaviors for mothers and children. Both experienced declines in energy, fat, and saturated fat to the recommended levels; decreased sweetened beverages, high fat snacks/desserts, added fats, and fast food restaurant consumption; and increased home-prepared meals and physical activity.

The child food frequency questionnaire and curriculum developed in this study can be used in public health and WIC clinics to assess food choices in children, to improve maternal nutrition knowledge, and to promote weight loss and beneficial diet and activity changes. This program could help prevent/treat obesity and associated risk factors (cardiovascular disease and diabetes) in low-income, mothers and their young child. Public health clinics and programs should focus on treating families for overweight, not just individuals, as children are eating many of the same foods as their parents. The social environment (i.e. home environment, parents, siblings) appears to the most powerful influence on the diet and activity of preschool children (Stang et al. 2004). As these children grow older, other aspects of the environment (peers, media/advertisement, schools) will have a more substantial impact, and intervention in the mother alone will not be effective. Thus, early intervention in mothers appears to be the easiest and most cost effective method for tackling the epidemic of child obesity.

One trend observed was that the mothers were more likely to decrease consumption of “less healthful” foods than to provide more nutrient-dense items. For example, overall energy and fat intakes declined, with subsequent reductions in several other nutrients. In addition, servings of fruits, vegetables, dairy, and whole grains did not increase significantly. Similar dietary changes also were evident in the mothers. Obese mothers who are aware that their child is at risk for overweight may report reductions in the foods/amounts offered to their child to be socially desirable. Educational programs promoting weight loss in the mothers should emphasize specific techniques for incorporation of vegetables, fruits, low-fat dairy, and fiber-rich foods in the diets of the mothers and children.

Recruitment, retention, and successful weight loss success in community-based programs delivered to low-income mothers rely heavily on the ability of the instructor to act as a cheerleader to motivate mothers to make behavioral changes. Educators should present success stories and promote a positive and supportive teaching environment. Additional strategies to enhance attendance include the provision of childcare and transportation.

Nevertheless, a number of low-income participants will not be successful at health behavior changes. These subjects may be less driven to make modifications, or may be experiencing life stressors or feelings of helplessness which make weight loss difficult. However, success of weight loss programs for low-income mothers should not be based solely on reductions in BMI, as many mothers also report better control over eating and prevention of further weight gain as benefits, even without substantial weight loss.

A limitation of the intervention study was the lack of a control group for comparison and randomization into groups; therefore, subjects served as their own controls. In addition, a longer-term follow-up and re-evaluation of eating habits and anthropometrics is needed to examine the sustainability of the behavioral changes. These techniques will be incorporated into future studies of weight loss using low-income mothers as agents of change.

An additional benefit of the weight loss program was the enhancement in nutrition knowledge of the mothers. Post-intervention mothers improved in all six areas of interest covered in the test. This population of primarily WIC mothers had the greatest knowledge of prenatal and child nutrition; thus, information about the Food Guide Pyramid, weight loss, energy nutrients, and sources/functions of vitamins and minerals is needed in this low-income population.

Women who lost more weight (responders) had higher pre- and post-test knowledge scores than non-responders. Throughout the program responders were more aware of diet and health links than women unable to lose weight. For example, post-test knowledge of responders was significantly higher than weight gainers in all categories, except the Food Guide Pyramid. However, the increases in knowledge among the responders were comparable to that seen in the non-responders. It appears that the majority of mothers were able to improve their knowledge, and those weakest at pre-test experienced the greatest improvements.

Responders did not differ in education, income, or any other demographic factors than non-responders or weight gainers. However, a larger percentage of Caucasians (76%) were responders than Hispanics (43%) and African Americans (36%) ($p<0.05$), and non-responders were more likely to be living alone ($p<0.05$). Weight gainers had more children in the household ($p<0.05$), weighed less pre-pregnancy ($p<0.05$), and were more likely to skip meals ($p<0.05$) and less likely to be Caucasian ($p<0.05$). Weight loss responders also were more motivated to attend classes and use pedometers and diet records for self-monitoring.

The food frequency questionnaire developed in this research for use with young children demonstrated excellent reliability and acceptable validity. This tool can be used in conjunction with diet recalls and records to improve the accuracy of the dietary data obtained. The FFQ also can be administered quickly and easily, in a community setting to examine the food choices of 1-3 year olds in the WIC and public health clinics. To date, this is the first FFQ designed to assess food choices in a tri-ethnic sample (Hispanic, African American, and Caucasian) of 1-3 year olds from low-income families.

Limitations of the validation study include the use of only three days of diet records for validation; however, it was not feasible to collect a greater number of diet records from the mothers in this study. Future validation studies should examine the performance of this questionnaire as compared to several days of diet records (Willett 1998) with the goal of increasing the food group validity correlations between the diet records and FFQ. Evaluation of test-retest reliability in a larger sample size also would be beneficial. Additionally, reliability and validity could be evaluated using nutrients so that the questionnaire can be used to assess both food choices and nutrient intakes. In this research nutrient intakes were measured via food recalls and records and food choices/fat habits with the FFQ.

It was apparent that mothers in this study had difficulty with portion sizes on the FFQ. Although detailed instruction was provided for determining portions, they reported slightly larger serving sizes for some foods on the diet records than the questionnaire. Respondents may have marked the "medium serving size" on the food frequency questionnaire to be "socially acceptable" or because it was difficult to evaluate a serving size for each food. Others have cited subject's difficulties with portion size estimation as a cause for lower validity correlations between the diet records and the questionnaire (Salvini et al. 1989, Haraldsdottir et al. 1994). To alleviate this problem, portion sizes may need to be modified to be even more age-specific. For example, creating two questionnaires, one with medium servings for 1-year olds and one with medium servings for 2-3 year olds, may enhance performance.

Although no children were still breastfeeding in this study, 14% offered their children formula at least once per day. Thus, an addendum to the questionnaire was added later that included different types of formula and breast milk. Since young children are frequently offered milk more than twice a day (the greatest response option available on this FFQ), the addendum also included nine new response options that ranged from “never or < once per month” to “7 + per day” for whole, 2%, 1%, skim milk, chocolate milk, formulas, and breast milk. Seven additional food items also were added that were present on the diet records but not the FFQ. The reliability and validity of this addendum should be tested.

A variety of physical, demographic, dietary, and psychosocial factors were examined for their correlation to child weight-for-height. Only the modifiable factors of greater mother’s weight and child’s inactivity and lower % energy from carbohydrate, and the non-modifiable factors of family history of diabetes and child’s age were significant. In the regression model these variables explained 29% of the variance in weight-for-height. Of this percentage, modifiable factors explained 16%. The above risk factors can be used to identify children that may benefit from early intervention. In addition, maternal psychosocial characteristics (i.e. depression, stress, social support) and nutrition knowledge and attitudes appeared to have little influence on child’s weight, presumably due to the young age of the children studied. No demographic differences in child weight were found. This could be attributed to the similarity in socioeconomic status of the participants.

Limitations of the study include the small sample size, resulting in diminished correlations, and the lack of longitudinal data to predict weight gain in these children. In addition, causality cannot be determined from the associations presented. Due to the convenience sampling, generalizability to other populations may be limited.

In sum, weight loss interventions for obese mothers of young children may promote beneficial dietary and activity outcomes in mother-child pairs. Additional research is needed to determine the most effective strategy for implementing the programs in the community setting. Trained peers educators may be one cost-effective method. This study also demonstrates that modifiable factors, such as mother's weight and child's activity and macronutrient distribution, begin to influence a child's weight at the age of 1-3 years.

Appendix A: Child Food Frequency Questionnaire

Please fill out the information below for your child with an age between 1 - 3 years.

Today's Date: ☐☐ ☐☐ ☐☐☐☐ Child's Age: ☐☐ months

m m d d y y y y

Child's Height: ☐☐ in. Child's Weight: ☐☐☐ lbs Child's Gender: ☐ M ☐ F

1. In the **past 2 months**, have you given your child <u>any</u> vitamins or minerals?

☐ No ☐ Sometimes ☐ Frequently ☐ All the Time

Multi-Vitamins		
☐ Multi-vitamin plus minerals (ex. Flintstones Chewables)	☐ Multi-vitamin	
☐ B-Complex	☐ Antioxidants/Phytochemicals	
Individual Vitamins/Minerals		
☐ Vitamin A	☐ Beta-carotene	☐ Vitamin C
☐ Vitamin E	☐ Folic acid, Folate	☐ Calcium, Tums
☐ Zinc, cold lozenges	☐ Iron	☐ Selenium
☐ Chromium	☐ Other	

2. Place an **X** in the box of all vitamins/minerals that you gave to your child.

3. For each vitamin or mineral, please list the following: 1) Name or brand, 2) Dose or number of pills; and 3) How long your child took them in weeks, months or years. Bring the bottle or label with you to your next visit to the project office. (use back of page if needed)

____

4. Has your child taken any other dietary supplements, herbs, homeopathic remedies, or botanicals in the **past 2 months** (e.g., St. John's Wort, echinacea, stevia)? ☐ No ☐ Yes

5. IF YES, please list what your child took, including: name, brand, dose, frequency (use back of page if needed).____

6. Why did you give your child supplements? (check all that apply)

☐ prevent disease & improve health ☐ treat existing condition ☐ more energy ☐ feel better

☐ addition to an inadequate diet ☐ other: ____

7. Was your child on any special diet in the **past 2 months**? ☐ No ☐ Yes, explain:____________________________________

Fill out the remaining questions about your child's consumption of foods over the **past 2 months**.
When did your child begin eating solid foods/baby foods (ex: baby cereal)? ______________________

8. Place an **X** in the boxes of the **2 fats** you usually used in cooking (to fry, stir-fry or sauté) foods for your child over the past 2 months.

☐ Low-fat margarine	☐ Lard, fatback, bacon fat	☐ Pam or No oil	☐ Olive oil
☐ Stick margarine	☐ Butter	☐ Vegetable oil	☐ Canola oil
☐ Soft tub margarine	☐ Crisco		

9. Place an **X** in the boxes of the **2 fats** you usually added to vegetables, potatoes, etc. for your child over the past 2 months.

☐ Low-fat margarine	☐ Lard, fatback, bacon fat	☐ Pam or No oil	☐ Olive oil
☐ Stick margarine	☐ Butter	☐ Vegetable oil	☐ Canola oil
☐ Soft tub margarine	☐ Crisco		

10. Did your child eat any commercially prepared low-fat or non-fat foods (e.g., WOW chips, low-fat cheese, low-fat/non-fat ice cream, light mayonnaise) the past 2 months? ☐ No ☐ Yes
Please list (use back of page if necessary):

11. In the past 2 months how often did your child eat the skin on chicken?
☐ Seldom/never ☐ Sometimes ☐ Often/always

12. In the past 2 months how often did your child eat the fat on meat?
☐ Seldom/never ☐ Sometimes ☐ Often/always

13. How often did your child eat the following foods from restaurants or carry-outs in the past 2 months?
Remember to include meals/snacks.

Restaurant Food	Never in the past 2 months	1-3 times per month	1 time per week	2-4 times per week	Almost every day
Fried Chicken	☐	☐	☐	☐	☐
Burgers	☐	☐	☐	☐	☐
Pizza	☐	☐	☐	☐	☐
Chinese/Thai Food	☐	☐	☐	☐	☐
Mexican Food	☐	☐	☐	☐	☐
Fried Fish	☐	☐	☐	☐	☐

14. What percent of your child's meals were prepared at: ___________% home ____________% family/friends _________% restaurant ________% fast foods ____________% grocery carry-out

(NOTE: These numbers should add up to 100%)

15. The next section is about **your child's eating habits over the past 2 months.**

Place an **X** in the box that best shows **how often**, on average, your child has eaten the food.
Do not skip any foods. **If your child never ate a food, mark the "never or less than once (<1) a month column"**
Place an **X** in the box that best shows your child's normal **serving size - small, medium, large or extra large**.

- A small serving is one-half the medium serving size shown.
- A large serving is one-and-a-half times the medium serving size shown.
- An extra large is two times the serving size shown.

	HOW OFTEN										HOW MUCH			
TYPE OF FOOD	**Never or < 1 Mon**	**1 Per Mon**	**2-3 Per Mon**	**1 Per Wk**	**2 Per Wk**	**3-4 Per Wk**	**5-6 Per Wk**	**1 Per Day**	**2+ Per Day**	**Child Medium Serving**	**Serving Size S**	**M**	**L**	**XL**
FRUITS (mashed, chopped, strained, canned, or whole) AND JUICES														
Apples, applesauce, apple butter, pears	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; 4 Tbsp; 1/4 c	☐	☐	☐	☐
Apple juice	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Apricots	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; 4 Tbsp; ¼ c	☐	☐	☐	☐
Bananas	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; 4 Tbsp; ¼ c	☐	☐	☐	☐
Berries: strawberries	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c; 3 small	☐	☐	☐	☐
Cantaloupe, honeydew, other melons	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c; 4 Tbsp	☐	☐	☐	☐
Grapes	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c; 6 small	☐	☐	☐	☐
Orange juice	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Oranges, tangerines	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; 4 Tbsp; ¼ c	☐	☐	☐	☐
Peaches, nectarines, plums	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; 4 Tbsp; ¼ cup	☐	☐	☐	☐
Pineapple: canned, fresh, frozen	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; 1/4 c	☐	☐	☐	☐
Prunes, prune juice	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 prune; 3 oz juice	☐	☐	☐	☐
Other real fruit juices: cranberry, grape, apple-banana, pear	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Other fruit: fruit cocktail	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c; 4 Tbsp	☐	☐	☐	☐
BREAKFAST FOODS (whole, cut up, or blended)														

	HOW OFTEN									HOW MUCH
TYPE OF FOOD	Never or < 1 Mon	1 Per Mon	2-3 Per Mon	1 Per Wk	2 Per Wk	3-4 Per Wk	5-6 Per Wk	1 Per Day	2+ Per Day	Child Medium Serving	Serving Size S M L XL
Bacon										1 slice	
Breakfast tacos										½ small taco	
Cereal, unsweetened: ready-to-serve dry cereal, fortified (e.g. Wheaties, Corn Flakes)										½ c	
Cereal, sugared: ready-to-serve dry cereal, fortified (e.g. Frosted Flakes, Fruit Loops)										½ c	
Cereal, from mix, for babies, fortified (rice, barley, oatmeal, wheat), with milk										½ c	
Cereal from mix for babies, fortified (rice, barley, oatmeal, wheat), with water										½ c	
Cereal cooked: (ex: Oatmeal, maltomeal, cream of wheat)										½ c	
Eggs, migas										1 egg	
Gerber graduates® cereal bars										1 piece	
Pancakes, waffles, French toast										1-4”pancake; 1 piece	
Sausage/Chorizo										1 pattie; 1-3.5”link	
Toaster Pastries: PopTarts										½ pastry	
VEGETABLES (chopped, strained, or whole)											
Avocado, guacamole										4 Tbsp, ¼ c	

	HOW OFTEN									HOW MUCH			
TYPE OF FOOD	**Never or < 1 Mon**	**1 Per Mon**	**2-3 Per Mon**	**1 Per Wk**	**2 Per Wk**	**3-4 Per Wk**	**5-6 Per Wk**	**1 Per Day**	**2+ Per Day**	**Child Medium Serving**	**Serving Size S**	**M**	**L**	**XL**
Beans: pinto, kidney, chili, lentils, black	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; ¼ c cooked	☐	☐	☐	☐
Beans: refried, baked, dip	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; ¼ c	☐	☐	☐	☐
Broccoli	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; ¼ c	☐	☐	☐	☐
Carrots	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; ¼ c	☐	☐	☐	☐
Corn (whole kernal)	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; ¼ c	☐	☐	☐	☐
Cucumber, pickles	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp; ¼ c	☐	☐	☐	☐
Lettuce salads	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c	☐	☐	☐	☐
Onions	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 slice; 1 scallion	☐	☐	☐	☐
Peas	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp, ¼ c	☐	☐	☐	☐
Potatoes, white: baked, boiled, mashed	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; ¼ c	☐	☐	☐	☐
Potatoes: french fries, hash browns, tator tots, potato salad	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
Spinach	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c raw; ¼ c cooked	☐	☐	☐	☐
Squash: zucchini, summer, yellow	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp, ¼ c	☐	☐	☐	☐
String beans, green beans	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp, ¼ c	☐	☐	☐	☐
Tomatoes	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 Tbsp, ¼ c	☐	☐	☐	☐
Ketchup, tomato sauce for dipping, barbecue sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 Tbsp	☐	☐	☐	☐
MEAT, FISH, POULTRY, MIXED DISHES (chopped, strained, whole)														
Beef: steaks, roasts, brisket, carne asada, barbecue	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 oz	☐	☐	☐	☐
Beef, mixed dishes: stew, hash, frozen entrees	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c	☐	☐	☐	☐

TYPE OF FOOD	HOW OFTEN: Never or < 1 Mon	1 Per Mon	2-3 Per Mon	1 Per Wk	2 Per Wk	3-4 Per Wk	5-6 Per Wk	1 Per Day	2+ Per Day	Child Medium Serving	HOW MUCH: Serving Size S	M	L	XL
Canned or microwavable convenience meals	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c	☐	☐	☐	☐
Chicken/turkey: roasted, stewed, broiled	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 oz	☐	☐	☐	☐
Chicken, fried, chicken nuggets	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm piece; 3 nuggets	☐	☐	☐	☐
Chicken/turkey dishes, mixed dishes: casserole, pot pie	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c	☐	☐	☐	☐
Fish: tuna, tuna salad	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
Fish, fried/fish sticks	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 oz; 1 stick ¼ sandwich	☐	☐	☐	☐
Fish, grilled or broiled	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 oz; 1 stick; ¼ sandwich	☐	☐	☐	☐
Ground beef	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm	☐	☐	☐	☐
Ham, Spam	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 oz	☐	☐	☐	☐
Hamburgers, cheeseburgers, meatloaf, meat sandwiches	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ sm; 1 oz patty	☐	☐	☐	☐
Hamburger Helpers, Chicken Helpers, or Tuna Helpers	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c	☐	☐	☐	☐
Hot dogs/corn dogs	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ hot dog	☐	☐	☐	☐
Beef/bean burritos, soft tacos, fajitas	☐	☐	☐	☐	☐	☐	☐	☐	☐	1/2 burrito	☐	☐	☐	☐
Cheese/beef enchiladas, tamales	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ med; 3 oz	☐	☐	☐	☐
Crispy tacos, chalupas	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ taco	☐	☐	☐	☐
Mixed dishes with cheese: macaroni and cheese	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
Mixed dishes: Chinese entrees	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
Pizza	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ of a 5.5" piece	☐	☐	☐	☐

	HOW OFTEN										HOW MUCH
TYPE OF FOOD	Never or < 1 Mon	1 Per Mon	2-3 Per Mon	1 Per Wk	2 Per Wk	3-4 Per Wk	5-6 Per Wk	1 Per Day	2+ Per Day	Child Medium Serving	Serving Size S M L XL
Pork: chops, roasts										1 oz	
Ribs: pork, beef										1 oz	
Soup: vegetable, tomato, tortilla, chicken noodle										1 sm bowl; ½ c	
Soup, cream based: cream of mushroom, broccoli										1 sm bowl; ½ c	
Soup, instant: Cup-of Soup, Ramen										1 sm bowl; ½ c	
Spaghetti, lasagna, other pasta with tomato sauce										½ c	
Pasta salad, noodles, fideo, pasta with butter/oil										½ c	
Toddler baby food containing chicken, fish, or poultry										½ c	
BREADS, SNACKS, SPREADS											
Biscuits, muffins, dumplings, scones, spoonbread										½ med (2.5”) piece	
Bread, white										½ slice	
Bread, dark: wheat, whole grain, rye, pumpernicke l										½ slice	
Bread: bagels, buns, English muffins										½ med (3.5”) piece	
Bread: corn bread, corn muffins, hush puppies										½ med (2”) piece	
Corn tortillas										½- 6” tortilla	
Flour tortillas										½- 7.5 ” tortillas	
Gerber graduates® wagon wheels										1 sm handful; ½ c	
Nuts: peanut butter, peanuts										1 Tbsp	
Nachos, potato skins with										3 nachos; ½ sm potato	

	HOW OFTEN										HOW MUCH
TYPE OF FOOD	Never or < 1 Mon	1 Per Mon	2-3 Per Mon	1 Per Wk	2 Per Wk	3-4 Per Wk	5-6 Per Wk	1 Per Day	2+ Per Day	Child Medium Serving	Serving Size S M L XL
cheese											
Pretzels, crackers	☐	☐	☐	☐	☐	☐	☐	☐	☐	2 saltines; 1 handful	☐ ☐ ☐ ☐
Rice: white, brown	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼- c	☐ ☐ ☐ ☐
Rice: Spanish, fried	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐ ☐ ☐ ☐
Snacks, salty: potato chips, corn chips, popcorn, tortilla chips	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 sm handful; ½ c	☐ ☐ ☐ ☐
DAIRY PRODUCTS											
Butter	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 pat;1 tsp	☐ ☐ ☐ ☐
Margarine	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 pat;1 tsp	☐ ☐ ☐ ☐
Cheese, hard: American, cheddar, Swiss	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 slice; 1 oz	☐ ☐ ☐ ☐
Cheese, processed: American cheese slice	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 slice; 1 oz	☐ ☐ ☐ ☐
Gravy, white sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 Tbsp	☐ ☐ ☐ ☐
Milk or Lactaid milk, whole	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 oz; ½ c	☐ ☐ ☐ ☐
Milk or Lactaid milk, 2%	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 oz; ½ c	☐ ☐ ☐ ☐
Milk or Lactaid milk, skim/non-fat, 1% milk, buttermilk	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 oz; ½ c	☐ ☐ ☐ ☐
Milk, chocolate	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 oz; ½ c	☐ ☐ ☐ ☐
Milk, soy	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 oz; ½ c	☐ ☐ ☐ ☐
Olive oil	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 tsp	☐ ☐ ☐ ☐
Salad dressing, mayonnaise	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 tsp	☐ ☐ ☐ ☐
Sour cream, cream dips	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 tsp	☐ ☐ ☐ ☐
Yogurt, frozen yogurt	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c; 2 oz	☐ ☐ ☐ ☐
SWEETS											
Candy	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 piece	☐ ☐ ☐ ☐

TYPE OF FOOD	HOW OFTEN: Never or < 1 Mon	1 Per Mon	2-3 Per Mon	1 Per Wk	2 Per Wk	3-4 Per Wk	5-6 Per Wk	1 Per Day	2+ Per Day	Child Medium Serving	HOW MUCH: Serving Size S	M	L	XL
Cookies, doughnuts, cakes, pastries, cinnamon rolls, brownies	☐	☐	☐	☐	☐	☐	☐	☐	☐	1-2" cookie; ½ -3"piece	☐	☐	☐	☐
Cookies, cake, pastry: low-fat/non-fat	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 cookie; ½ piece	☐	☐	☐	☐
Cookies: animal cracker, cinnamon grahams	☐	☐	☐	☐	☐	☐	☐	☐	☐	2 animal crackers; 2 cinnamon grahams	☐	☐	☐	☐
Fruit snacks: Fruit Roll Ups, Gushers, Fruit-by-the-Foot	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ package	☐	☐	☐	☐
Granola bars, chewy	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 bar	☐	☐	☐	☐
Ice cream: cones, milkshakes, sundaes	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
Jell-O, sherbet	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
Pudding, milk-based: vanilla, chocolate, rice, flan, custard	☐	☐	☐	☐	☐	☐	☐	☐	☐	¼ c	☐	☐	☐	☐
BEVERAGES														
Fruit drinks: Hi-C, Kool-Aid	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Soft drinks, soda: Coke, Sprite, RC, Orange, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Soft drinks, diet soda: Diet Coke, Diet Pepsi, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Soft drinks, other: Gatorade, Snapple, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐	3 oz	☐	☐	☐	☐
Tea	☐	☐	☐	☐	☐	☐	☐	☐	☐	½ c	☐	☐	☐	☐
Sugar, syrup, jams, honey	☐	☐	☐	☐	☐	☐	☐	☐	☐	1 tsp	☐	☐	☐	☐
Glasses of water	☐	☐	☐	☐	☐	☐	☐	☐	☐	4 oz	☐	☐	☐	☐

16. Are there any other foods that your child ate or drank (e.g., Gerber Graduates foods, smoothies, queso, bread pudding, wine or beer, etc.) over the past 2 months?

☐ No ☐ Yes

Food (list ingredients, brand name, etc.)	Serving Size (cups, ounces, teaspoons, handfuls, etc.)	Number of Servings per Month

	AVERAGE USE IN THE PAST 2 MONTHS								
	Less than once per week	1 - 2 per week	3 - 4 per week	5 - 6 per week	1 per day	1 ½ per day	2 per day	3 per day	4+ per day
17. How often do you use fat/oil in cooking foods for your child?	☐	☐	☐	☐	☐	☐	☐	☐	☐
18. About how many servings of vegetables does your child eat, not counting salad or potatoes?	☐	☐	☐	☐	☐	☐	☐	☐	☐
19. About how many servings of fruit does your child eat, not counting juices?	☐	☐	☐	☐	☐	☐	☐	☐	☐
20. About how many servings of cold cereal does your child eat?	☐	☐	☐	☐	☐	☐	☐	☐	☐

21. The remaining section includes additional questions about **your child's eating habits over the past 2 months.**

Place an **X** in the box that best shows **how often**, on average, your child has eaten the food.
Do not skip any foods. **If your child never ate a food, mark the "never or less than once (<1) a month column"**
Place an **X** in the box that best shows your child's normal **serving size - small, medium, large or extra large**.

- A small serving is one-half the medium serving size shown.
- A large serving is one-and-a-half times the medium serving size shown.
- An extra large is two times the serving size shown.

	HOW OFTEN										HOW MUCH			
TYPE OF FOOD	**Never or < 1 Mon**	**1-3 Per Mon**	**1-2 Per Wk**	**3-4 Per Wk**	**5-6 Per Wk**	**1-2 Per Day**	**3-4 Per Day**	**5-6 Per Day**	**7+ Per Day**	**Child Medium Serving**	**Serving Size S**	**M**	**L**	**XL**
Formula, milk-based, iron-fortified: Enfamil, Similac										4 oz; 1/2 c				
Formula, soy, iron-fortified: Isomil, Carnation Alsoy, Prosobee										4 oz; 1/2 c				
Formula, milk-based, low-iron: Enfamil low iron, Similac low iron										4 oz; 1/2 c				
Formula, lactose-free: Enfamil lacto-free, Similac lactose free										4 oz; 1/2 c				
Formula, special: Nutramigen, Pregestimil, Enfamil A.R. Please list type:_________										4 oz; 1/2 c				
Formula for toddlers: Enfamil Next Step Toddler Formula										4 oz; 1/2 c				
Breast milk										4 oz; 1/2 c				
Milk or Lactaid milk, whole										4 oz; ½ c				
Milk or Lactaid milk, 2%										4 oz; ½ c				
Milk or Lactaid milk, skim/non-fat, 1% milk, buttermilk										4 oz; ½ c				
Milk or Lactaid milk, chocolate										4 oz; ½ c				
Milk, soy										4 oz; ½ c				

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